110690

FINAL

PHASE I RI/FS WORK PLAN

CROYDON TCE SITE
BUCKS COUNTY, PENNSYLVANIA

AUGUST 1987

EBASCO SERVICES INCORPORATED

EBASCO

One Oxford Valley, Suite 414, 2300 Lincoln Highway - East, Langhorne, PA 19047, (215) 752-0212

August 31, 1987
RM/3/87-0251

Mr. Harry Harbold
Environmental Protection Agency
Region III
841 Chestnut Street
Philadelphia, PA 19047

Subject: REM III PROGRAM - EPA CONTRACT NO. 68-01-7250
WORK ASSIGNMENT NO. 124-3LM7
CROYDON TCE SITE, BUCKS COUNTY, PENNSYLVANIA
FINAL PHASE I RI/FS WORK PLAN

Dear Mr. Harbold:

Enclosed for your review are four (4) copies (3 bound and 1 unbound) of the Final Phase I RI/FS Work Plan for the Croydon TCE Site. The supporting REM III Team level of effort and cost estimates for conducting this work are being sent to you under separate cover.

In accordance with the project schedule, we look forward toward your approval of the Final Work Plan and cost estimates by Monday, September 7, 1987.

If you have any questions or comments regarding this report, please feel free to contact me or our Site Manager, Mr. Raymond P. Wattras at 412/788-1080.

Very truly yours,

Richard C Evans, P.E.
Regional Manager, Region III

RCE/DEM/js

cc: A Ferdas - EPA, Region III
M Yates - ZPMO
M Amdurer - ZPMO
A Bomberger - NUS
R Wattras - NUS
P Krantz - EPA, Annapolis Laboratory

AR300002

AUGUST 1987

FINAL

PHASE I RI/FS WORK PLAN

CROYDON TCE SITE
BUCKS COUNTY, PENNSYLVANIA

EPA WORK ASSIGNMENT NUMBER 124-3LM7
UNDER
CONTRACT NUMBER 68-01-7250

PREPARED BY:
NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED BY:
EBASCO SERVICES INCORPORATED
LANGHORNE, PENNSYLVANIA

PREPARED BY:

Raymond P. Wattras

RAYMOND P WATTRAS
SITE MANAGER
NUS CORPORATION

APPROVED BY:

RICHARD C EVANS, PE
REGIONAL MANAGER, REGION III
EBASCO SERVICES INCORPORATED

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

FIGURES

TABLES

1.0 INTRODUCTION

NUS Corporation (NUS), under contract to Ebasco Services Incorporated (EBASCO), is pleased to submit this Final Phase I Work Plan for the Croydon TCE Site Remedial Investigation/ Feasibility Study (RI/FS) to the U.S. Environmental Protection Agency (EPA). Preparation of this Work Plan was accomplished in response to Work Assignment Number 124-3LM7 under EPA Contract Number 68-01-7250 pursuant to the Work Plan Memorandum (WPM) dated March 17, 1987.

The Croydon TCE Site RI/FS will be conducted in two phases. This is necessary because the source of the groundwater contamination is unknown and there is only a limited amount of data for the study area. The Phase I RI/FS will focus on defining the extent of a known groundwater plume contaminated with trichloroethene (TCE) and other volatile organics, and assessing the public health risks of those residences who depend on groundwater as a source of potable water. If the source of contamination is identified, or if data are collected to estimate potential source areas during the Phase I RI, then a Phase II RI/FS will be conducted to focus on defining and remediating the source(s) of contamination. Additionally, if the extent of groundwater contamination within the study area is greater than anticipated, a Phase II RI/FS will be conducted and the study area will be expanded. This scenario is possible based on widespread groundwater contamination throughout portions of Bucks County, Pennsylvania. The objectives of the Phase II RI/FS will be developed during the Phase I RI.

This Final Phase I RI/FS Work Plan will only outline the Phase I activities, with the exception of developing a Phase II Work Plan. The work plan describes the scope of work, resources, and budget necessary to collect the data needed to define present and potential health and environmental risks and to evaluate the feasibility of potential remedial alternatives for the Croydon TCE Site. The methodology and approach used to establish the project objectives and the RI/FS scope of work follow the latest EPA and REM III guidance for planning and implementing a remedial investigation and feasibility study. This guidance is based on the requirements of the Superfund Amendments and Reauthorization Act (SARA) of 1986, which emphasizes the RI/FS "scoping process" and a phased RI and FS.

The RI/FS Work Plan consists of 6 sections, including this Introduction (Section 1.0). Section 2.0 provides a description of the site with respect to the location, general layout, and physical characteristics. Section 3.0 outlines the scoping of the Phase I RI/FS and includes the following:

- Summary of the existing site data
- Results of the preliminary risk assessment
- Listing of Applicable or Relevant and Appropriate Requirements (ARARs)

- Summary of potential remedial alternatives
- Listing of data limitations and requirements
- Description of the specific project objectives
- Summary of Data Quality Objectives (DQOs)

Eight tasks have been identified to conduct the Phase I RI for the Croydon TCE Site. Section 4.0 of this report describes these tasks. The FS tasks (Tasks 9 through 12) are described in Section 5.0. Project management activities, including the project organization, quality assurance and data management, schedule, and cost estimates are provided in Section 6.0.

2.0 SITE BACKGROUND INFORMATION

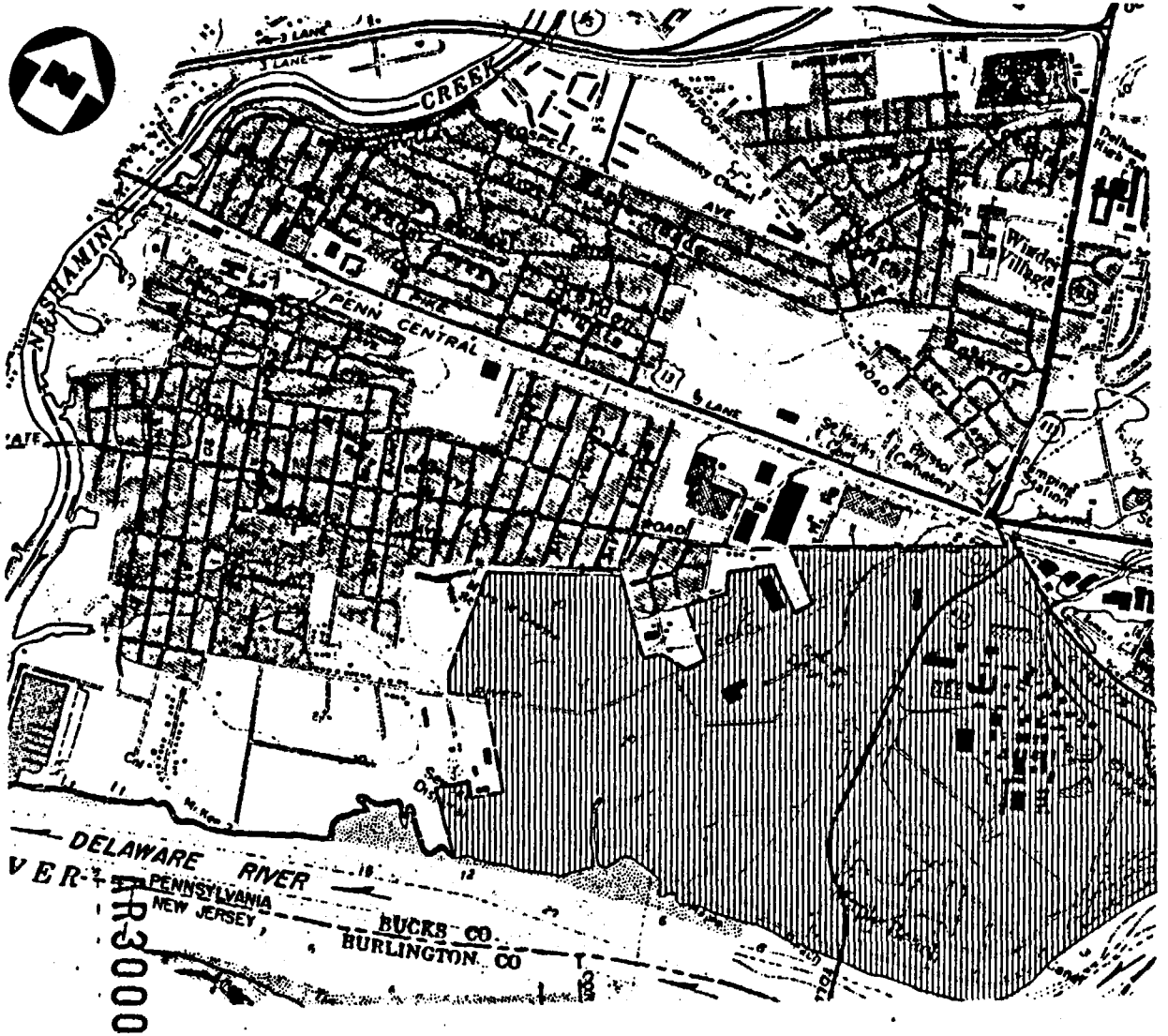
2.1 SITE DESCRIPTION

The Croydon TCE Site is located in Bristol Township, Bucks County, Pennsylvania (Figure 2-1). Analytical data from residential wells and surface water sampled in this area detected elevated levels of trichloroethene (TCE), tetrachloroethene (PCE), and other organic and inorganic contaminants. The source of this contamination has not yet been defined and therefore, a site boundary was not established. (A review of the Hazard Ranking System reference documents revealed no description of a site boundary or a source of contamination.) However, a boundary for this investigation has been established and will be referred to as the "study area". This area encompasses approximately 4 square miles and is depicted in Figure 2-2.

As shown in Figure 2-2, the study area is bordered by Interstate 95 to the north, the Rohm & Haas Company property and the Delaware River to the south, Neshaminy Creek to the west, and Route 413 to the east. The Rohm & Haas Company property contains a landfill which is under investigation by EPA for alledgedly contaminating the groundwater south of the study area (i.e., south of River Road). The Croydon TCE Site RI/FS will focus on the area north of the Rohm & Haas property since EPA is currently studying the landfill area and efforts would be duplicated (Rohm & Haas has procured a subcontractor to study the landfill area). Additionally, there is evidence that the groundwater contamination in the Croydon community is not the result of the Rohm & Haas landfill (BCM, 1986a).

The criteria for establishing the study area boundary were based on, 1) potential widespread groundwater contamination in this portion of Bristol Township (BCM, 1986a), 2) potential source areas identified by the EPA Environmental Photographic Interpretation Center (EPIC), and 3) natural boundaries such as Neshaminy Creek and the Delaware River. Interstate 95 and Route 413, which comprise the northern and eastern borders of the study area, were selected only to limit the study area to a reasonable size. Based on the finding of this Phase I RI/FS, the study area boundaries will be re-evaluated and may expand to include other areas.

The study area includes a number of residential communities that were constructed mainly in the 1940s-1960s. These communities include Croydon, Croydon Heights, Croydon Acres, Maple Shade, West Bristol, Belardy, and Rockdale. Croydon is the largest of the residential areas and encompasses the area south of U.S. Route 13 (Bristol Pike) and north of the Delaware River (See Figure 2-2). The remaining residential areas comprise the area north of U.S. Route 13. State Road and River Road, which cross through the Croydon area, run parallel with U.S. Route 13 and eventually form a five-way intersection with Routes 413



LEGEND

Study Area Boundary

Rohm and Haas Company Property

QUADRANGLE LOCATION

BASE MAP IS AN ENLARGEMENT OF A PORTION OF THE U.S.G.S. BEVERLY, PA-NJ QUADRANGLE (7.5 MINUTE SERIES, 1966, PHOTOREVISED 1973, CONTOUR INTERVAL 20 FEET) AND A PORTION OF THE BRISTOL, PA-NJ QUADRANGLE (7.5 MINUTE SERIES, 1955, PHOTOREVISED 1961, CONTOUR INTERVAL 20 FEET)

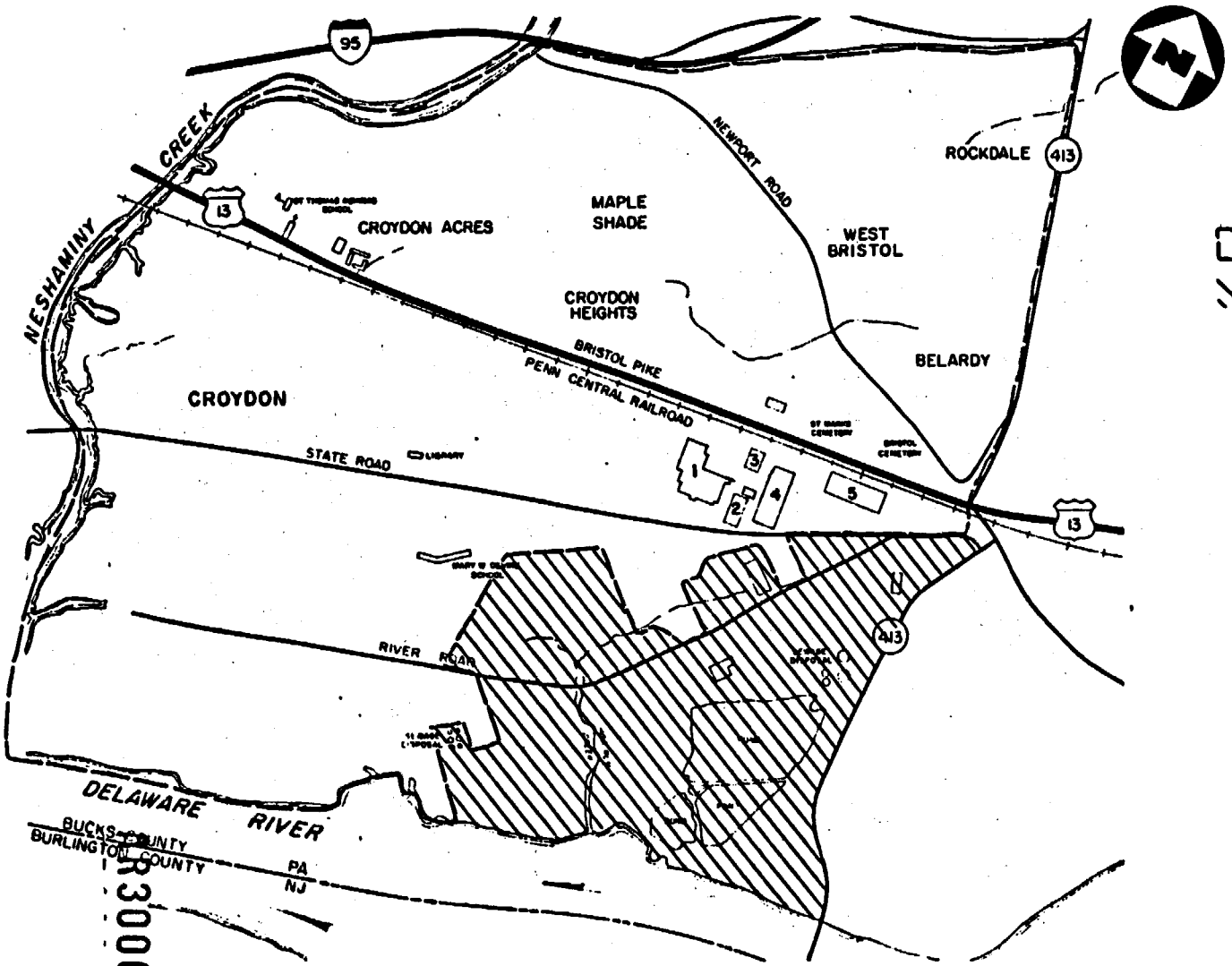
0 1000 2000 3000 4000

SCALE IN FEET

FIGURE 2-1

LOCATION MAP
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION



LEGEND

- Study Area Boundary
- Rohm and Haas Company Property

RESIDENTIAL AREAS

- Belardy
- Croydon
- Croydon Acres
- Croydon Heights
- Maple Shade
- Rockdale
- West Bristol

BUILDINGS

1. Owens-Illinois
2. Alpha Aromatics
3. Bristol Flare
4. Mack Warehouse
5. Coyne Chemical

0 1000 2000 3000 4000
SCALE IN FEET

FIGURE 2-2

GENERAL ARRANGEMENT
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION

R300014

and 13. This intersection forms the southeastern corner of the study area. Commercial establishments including gas stations, restaurants, dry cleaners, bakeries, and auto repair shops are located along U.S. Route 13 and State Road.

Population figures were not available for the individual communities. Based on a review of tax maps, it is estimated that the population within the study area could range between 2,000 to 3,000 residents.

The study area is serviced by the Bristol Borough Water Authority; however, a number of streets are not connected to the municipal water supply. A questionnaire, which was prepared to locate homes without the services of a public water supply, identified a total of 38 residences that depended on groundwater as a source of potable water. (This questionnaire was limited to the study area).

A number of light to heavy industries are located in the southeastern portion of the study area between U.S. Route 13 and State Road. This portion of the study area may be a potential source of the groundwater contamination, based on the EPIC investigation, which identified 13 potential waste sources, and on studies conducted by BMC Inc. for the Rohm & Haas Company. As shown on Figure 2-3, the potential source areas extend from just north of U.S. Route 13 (Source Area No. 1) to the Rohm & Haas Company's sewage disposal area (Source Area No. 12).

The potential source areas were identified by analysis of historical aerial photographs for the period 1940 to 1978. The source areas were identified as potential threats to the groundwater based on the presence of features or "signatures" associated with different environmental conditions. The "signature" refers to a combination of characteristics (such as color, tone, shadow, texture, and size) which indicate a specific object or condition (USEPA, 1985b). These "conditions" usually referred to such things as excavated areas, standing liquids, mounded materials, stained soils, and storage areas for drums and/or tanks.

It appears, from review of the latest (1978) aerial photograph, that no evidence of adverse environmental conditions existed at many of the thirteen potential source areas. This could be due to any number of reasons. For example, at Potential Source Area No. 4, a pool of dark-toned standing liquid was observed in an excavated area as depicted by an aerial photograph taken in 1970. However, the 1978 photographic analysis found that 4 industrial buildings have been built over the excavated area, completely covering any signs of the previous excavated areas. Thus, the excavated area was completely filled between 1970 and 1978.

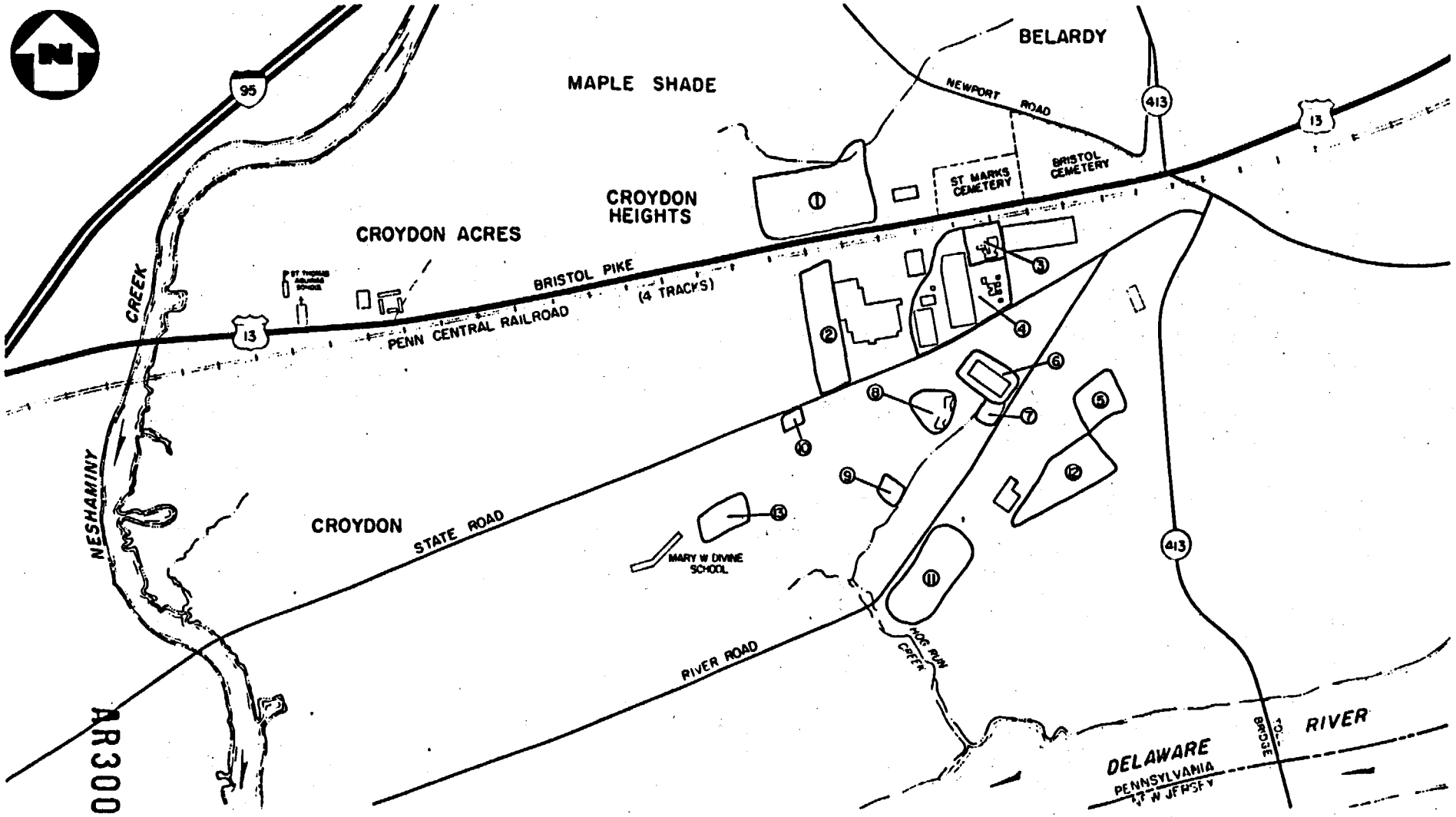


FIGURE 2-3

POTENTIAL SOURCE AREAS
CROYDON TCE SITE, BUCKS COUNTY, PA

0 1000 2000
SCALE IN FEET

NUS CORPORATION

The following facilities are located either within or near these potential source areas (See Figure 2-2).

- Owen-Illinois Corporation (corrugated and solid box manufacturing)
- Alpha Aromatics (food processing)
- Bristol Flare Corporation (manufacturer of fuses and railroad flares)
- Coyne Chemical (warehouse and distributor of chemical products)
- Croydon Fuel Company (fuel oil distributer)
- E. Forrest & Sons, Inc. (contractor)

At this time, it is not clear whether any of the above facilities are responsible for the groundwater contamination.

2.2 SITE HISTORY

The site was discovered by investigations undertaken by the Rohm & Haas Company, which operated a manufacturing facility near the Croydon community. Rohm & Haas performed a number of environmental investigations to determine the source of TCE contamination in the vicinity of River Road and Hog Run Creek. TCE in groundwater was believed to be emanating from a landfill which was owned by Rohm & Haas (see Figure 2-2). A number of environmental investigations have suggested that the source of TCE contamination may be from sources other than the Rohm & Haas Landfill (BCM, 1986a).

In April 1985, the NUS Corporation Field Investigation Team (FIT) prepared a Hazard Ranking Score (HRS) for the Croydon TCE Site. A HRS of 31.60 was calculated for the Croydon TCE Site. This was based on the findings of the Rohm & Haas investigations, which included data for groundwater, surface water (Hog Run Creek), and sediments. Because the source of contamination was unknown, a site boundary could not be established. In September 1985, the Croydon TCE Site was selected for inclusion on the National Priorities List (NPL) and ranked 616th.

2.3 GEOLOGY

The geology of the Croydon TCE Site consists of unconsolidated sand, gravel, silt, and clay deposits overlying metamorphic bedrock. The site is located within the Coastal Plain Physiographic Province, approximately 4 miles southeast of the northwest trending outcrop of metamorphic rocks that forms the Fall Line. A narrow bank of metamorphic bedrock is exposed south of the Fall Line along the stream valley of Neshaminy

Creek in the area (Greenman, 1955). This outcrop area extends southward along the stream to just south of U.S. Route 13, in the northwestern part of the study area.

Unconsolidated deposits within the study area consist of Quaternary age deposits, primarily Pleistocene (Wisconsin) age glacial outwash in the form of valley fill deposits overlain by a thin veneer of recent alluvium, which may be underlain by Upper Cretaceous age nonmarine sediments. The Quaternary outwash deposits are generally erratic and discontinuous, and are made up primarily of sand and gravel with minor amounts of silt and clay. There is a general fining upward trend to the deposits. Recent alluvium forms a thin veneer overlying the valley fill deposits and is primarily fine grained flood plain and channel deposits. Upper Cretaceous sediments that may be present beneath the Quaternary sediments belong to the Raritan Formation, which consists of a series of nonmarine sedimentary sequences of gravel, sand, and clay. The individual deposits are generally lenticular and discontinuous and are similar to the overlying younger deposits, however, a dense clay is reported to consistently mark the top of the formation. The Raritan Formation, where present, rests directly on bedrock (Greenman, 1955; Owens, et al., 1964).

Several monitoring wells have been drilled in the study area during investigations of the Rohm & Haas manufacturing facilities and landfill. The boring logs for the wells confirm the expected geologic conditions in the unconsolidated deposits, as described in this section. Total thickness of the unconsolidated deposits in the well borings ranged from approximately 40 to 65 feet (BCM, 1986a).

Bedrock underlying the unconsolidated deposits is described as the Wissahickon Schist, a late Precambrian-Early Paleozoic metamorphic rock unit of probable sedimentary origin, which is considered the basement rock in the area. This unit is described as being gneissic to schistose in character, with abundant mica and significant amounts of feldspar, quartz, and chlorite. Foliation of platy minerals within the unit generally strikes northeast, and both the foliation and relict bedding within the formation have overall dips to the southeast (Kammerer, 1953). The bedrock surface is irregular, and has an overall regional slope to the southeast. Local information suggests that a low bedrock ridge is present immediately south of the study area, resulting in a local northeast slope of the bedrock surface in the southeastern part of the study area, contrary to the regional trend (BCM, 1986a).

2.4 HYDROGEOLOGY

Groundwater occurs in both the unconsolidated deposits and in the underlying bedrock within the study area. The two flow systems are interconnected except where local clay layers separate the two, or where a substantial thickness of weathered

bedrock (saprolite) inhibits the movement of groundwater between formations, due to its reported low hydraulic conductivity (BCM, 1986a). The overall regional flow direction in both flow systems is to the southeast towards the Delaware River, which is the regional groundwater discharge point. Local variations to groundwater flow directions occur in the vicinity of smaller streams, such as Neshaminy Creek and possibly Hog Run Creek, which serves as intermediate discharge points for groundwater. The overall groundwater flow direction in the study area is expected to be to the southeast, following the regional trend.

The saprolite ridge identified to the south of the site area may alter groundwater flow patterns in the unconsolidated deposits on a local scale (BCM, 1986a). However, the effect of this subsurface ridge is not well defined at this time.

In the site area and to the southeast, the unconsolidated deposits form the main source of domestic and industrial groundwater supply. Groundwater in these deposits occurs under unconfined to semiconfined conditions. Occasional low permeability silt and clay deposits serve as confining layers to groundwater flow; however, the lateral extent of any individual unit is expected to be small and the local semiconfined conditions created are not expected to be of major importance to the study. The upper clay unit of the Raritan Formation may form a more extensive confining layer if present (Greenman, 1986); however, available boring logs do not identify this unit in the study area.

Water quality, where not affected by human activities, is generally good and is characterized as acidic and soft, with low Total Dissolved Solids (TDS) (Greenman, 1986). The overall hydraulic conductivity of the unconsolidated deposits is high, and well yields in excess of 100 gpm are not uncommon. Recharge to the groundwater flow system within the unconsolidated deposits is from both precipitation and subsurface drainage.

Based on the guidance presented in "Guidelines for Ground Water Classification Under the EPA Ground Water Protection Strategy" (EPA, 1986C), this aquifer is considered a Class IIA aquifer. It is currently used as a source of drinking water, but is not considered as an irreplaceable source of drinking water, nor is it known to be ecologically vital.

The bedrock groundwater flow system is of minor importance for groundwater supply in the site area. There is currently no data describing any bedrock groundwater users in the local area, probably due to the ready availability of adequate groundwater supplies in the overlying unconsolidated deposits. Groundwater occurrence and movement in the metamorphic bedrock beneath the site is controlled primarily by fractures, with schistosity, cleavage, and bedding planes also contributing factors. Primary porosity within the bedrock unit is essentially nonexistant, as

is typical of crystalline bedrock units. Where groundwater is obtained from the unit for water supply (in areas to the northeast) the overall water quality is good, with low hardness and TDS (Hall, 1973; Greenman, 1955).

Average well yields in the Wissahicken Schist are approximately 23 gpm (Hall, 1973). Incised stream channels in the bedrock surface can be high yielding zones, where the channel has been filled with coarse sand or gravel (Greenman, et. al., 1961). Recharge to the bedrock flow system is from precipitation infiltration in outcrop areas, and from groundwater migration from overlying unconsolidated deposits.

2.5 SURFACE WATER HYDROLOGY

The site is situated within the Delaware River Basin. The Delaware River forms a portion of the southern boundary of the study area and is the regional discharge point for both groundwater and surface waters. Neshaminy Creek, flowing southward along the western edge of the study area, is a major tributary of the Delaware River. Groundwater from the western edge of the study area is expected to discharge into this creek. Hog Run Creek, located along the southern and southeastern study area boundary, is a minor tributary to the Delaware River. Some shallow groundwater from the southeastern part of the study area discharges to this stream; however, deeper groundwater probably flows under the stream and discharges at the Delaware River.

The Delaware River is tidal-influenced up to and beyond the study area. The lower stretches of both Neshaminy Creek and Hog Run Creek (south of the study area) are influenced by the tides. The tidal influence on Hog Run Creek does not extend up to the study area, while the tidal influence on Neshaminy Creek extends up into the southwestern part of the study area.

3.0 SCOPING OF THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

The Croydon TCE Site primarily involves groundwater and surface water contamination of TCE and PCE. Groundwater is used as a source of potable water by some of the homes within the study area. The other homes are connected to the Bristol Borough public water supply. The area of investigation is approximately 4 square miles. Groundwater and surface water data is available only for the southeastern portion of the study area. The remainder of the study area, particularly north of State Road to Interstate 95, has not been investigated. To date, the source of the groundwater and surface water contamination has not been determined.

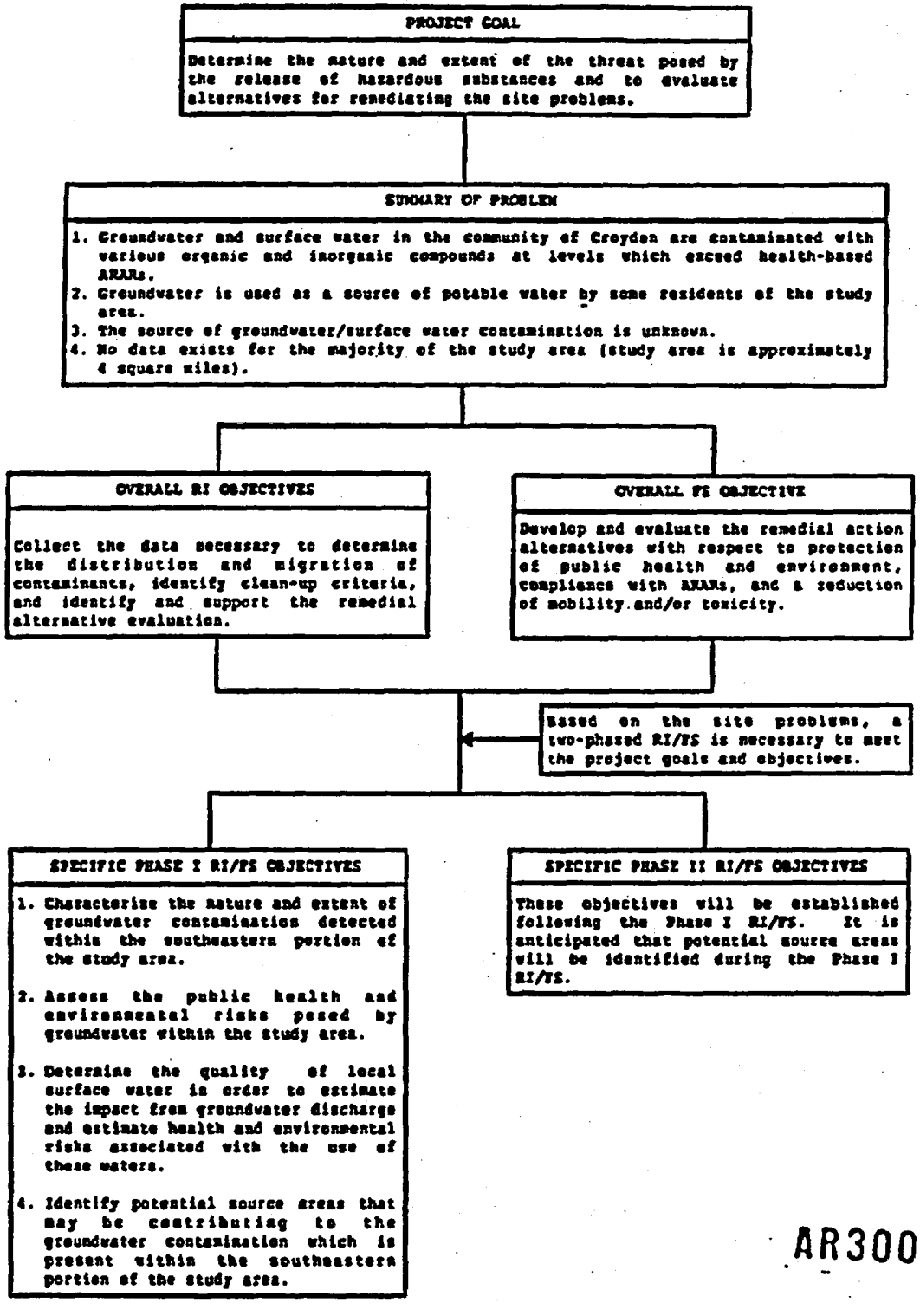
The project goal for the Croydon TCE Site RI/FS is to determine the nature and extent of the threat posed by the release of hazardous substances and to evaluate alternatives for remedying the site problem(s). The overall objective of the RI is to collect the necessary data to determine the distribution and migration of contaminants, identify cleanup criteria, and identify and support the remedial alternative evaluation. The objectives of the FS are to develop and evaluate the remedial action alternatives with respect to protection of public health and environment, compliance with Applicable or Relevant and Appropriate Requirements (ARARs), and a reduction of mobility and/or toxicity.

Because little information is available for most of the study area, and no source of contamination has been identified, a two-phased RI/FS will be conducted. The Phase I RI/FS is described in this Work Plan. Specific objectives for the Phase I RI/FS have been established and are outlined in Figure 3-1. Once these objectives are met, a Phase II RI/FS Work Plan will be prepared. The Phase II RI/FS will focus on delineating potential source areas if they are identified during the Phase I RI. In addition, if the groundwater within the study area is profound, then the study area may be expanded and a Phase II RI/FS will be initiated. The Phase II RI/FS objectives will be established following the Phase I study.

The scoping of the Croydon TCE RI/FS was accomplished by initially reviewing existing analytical data within the study area for groundwater, soil, air, surface water, and sediments. Data were then summarized and evaluated to determine existing and potential contaminant migration and exposure routes. A preliminary risk assessment was conducted to evaluate the effect of the site contaminants on public health and the environment. In addition, existing data were compared to health-based ARARs to identify target compounds which exceed EPA criteria. The results of the preliminary risk assessment and the comparison of site contaminants with ARARs, lead to the identification of preliminary remedial technologies and alternatives for remediating the site problems.

AR 300022

FIGURE 3-1
RI/FS SCOPING DIAGRAM
CROYDON TCE SITE



AR300023

Data limitations were identified through the preliminary risk assessment, ARAR determination, and the scoping of preliminary technologies and remedial alternatives. The data limitations reflect that information which is needed to assess the present and potential public health and environmental risks, and to evaluate feasible remedial alternatives. Once the data limitations were determined, various activities were identified that would collect the appropriate information (i.e., groundwater sampling). Data Quality Objectives (DQOs) were then established to ensure that the quantity and quality of data are sufficient to satisfy the data requirements.

The remainder of this section documents the findings of the scoping process and identifies the specific RI/FS objectives for meeting the project goals.

3.1 SUMMARY OF EXISTING DATA

This section provides a summary of existing chemical characterization data, based on previous reports, which focused on or nearby the Croydon TCE study area. These reports include the following:

- BCM Eastern Inc. (BCM). 1984a. Report on Landfill Investigation. April 1984.
- BCM Eastern Inc. (BCM). 1984b. Analysis of Residential Wells. Letter to Mr. Robert Lewis, Bristol Township Board of Supervisors. June 11, 1984.
- BCM. 1986a. TCE in Groundwater in the Vicinity of River Road, Bristol Township, Pennsylvania. Prepared for Rohm & Haas Company. BCM Project No. 00-4061-12. March 1986.
- BCM. 1986b. Report of PCE Groundwater Investigation. Prepared for Rohm & Haas Company, Bristol, Pennsylvania. BCM Project No. 00-4016-16. April 1986.
- BCM. 1986c. Landfill Groundwater Sampling. February 1985 and July 1985. Prepared for Rohm & Haas Company. BCM Project No. 00-4061-14.

Groundwater data indicate that trichloroethene (TCE), tetrachloroethene (PCE), and other aliphatic volatiles are present in the southeastern portion of the study area; however, the extent of this contamination (especially north of River Road and west of Linton Avenue) has not been defined. Soil data are limited. Only four samples were collected within the Croydon study area, near the Mary W. Devine School. Low concentrations of arsenic, barium, zinc, and lead were reported for these samples. Most of the soil data presented in the above-referenced reports were collected from the Rohm & Haas Landfill

area. These soil data were not considered as "existing site data" since the landfill is downgradient from the site area.

Surface water and sediment data for the Croydon study area were collected from Hog Run Creek and its tributaries. Both aliphatic and aromatic organic pollutants were detected in the surface water samples. Sediment contamination primarily consisted of polynuclear aromatic hydrocarbons (PAHs). The only volatile contaminants included TCE (10-11 µg/kg) and methylene chloride (15-480 µg/kg). Samples taken from "seeps" along Hog Run Creek revealed the presence of aliphatic and aromatic compounds, and a pesticide (lethane). Another compound, which was identified in the report as "DNCP", could not be identified. DNCP may be a trade name for a Rohm & Haas product. The location of the "seep" samples was not given in the report. It is possible that the seep samples were collected along the portion of Hog Run Creek which borders the Rohm & Haas landfill (See Figure 2-2).

The data obtained from the above-referenced reports should only be used to evaluate the presence or absence of contamination in a particular medium. Information regarding the analtyical methods, detection limits, and QA/QC (validation) was often lacking. Additionally, only TCE and PCE were reported for many of the samples, without an explanation of whether other contaminants were detected or analyzed for.

Provided below is a summary, by media, of the existing data.

Soils

Surface soil sampling within the study area included four samples (composites at 0-0.5 feet) that were collected in October and November 1983 (BCM, 1984a). These samples were collected from the Mary Devine School property and the baseball fields adjacent to the school. Arsenic (0.32-4.2 mg/kg), barium (15.4-54.4 mg/kg), copper (4.39-7.27 mg/kg), lead (19.5-28.5 mg/kg), zinc (25.0-84.9 mg/kg) were detected in the soil samples. Methylene chloride (11 µg/kg) was the only organic compound detected in these four samples; however, the presence of methylene chloride is most likely due to laboratory contamination.

BCM installed 12 test borings in March 1985 in the study area (north of River Road). Samples of those borings were collected and analyzed for trichloroethene (TCE). Trichloroethene was not reported in any of these samples.

Surface Water and Sediments

Surface water samples of Hog Run Creek have been collected by BCM and EPA FIT III. Table 3-1 lists the compounds that were detected in Hog Run Creek surface water samples and their reported range of concentration. Surface water samples were

also collected from seeps along Hog Run Creek. The compounds detected in the seep samples include lethane (1.0 µg/l), DNCP (30 µg/l), 1,4-dichlorobenzene (80 µg/l) 1,1,1-trichloroethane (1.0 µg/l), trichloroethane (1.1 µg/l), and bis(2-ethylhexyl) phthalate (27.0 µg/l).

Sediment samples were also collected by BCM from Hog Run Creek. Table 3-2 lists the compounds that were detected in the Hog Run Creek sediment samples and their reported range of contamination.

Groundwater

Groundwater samples have been collected from monitoring wells installed by BCM and from nearby residential wells as shown in Figure 3-2. The monitoring wells were installed in phases as part of an ongoing groundwater investigation. Groundwater sampling occurred in October 1983, February 1984, April 1984, May 1984, January 1985, February 1985, and March 1985. Table 3-3 lists the compounds detected in the monitoring wells and the range within which they were detected.

Inorganic compounds were not analyzed for after the 1983 sampling. In the first round of sampling, only arsenic (0.118 and 0.09 mg/l) and chromium (0.055 mg/l) exceeded EPA's Interim Primary Drinking Water Standards.

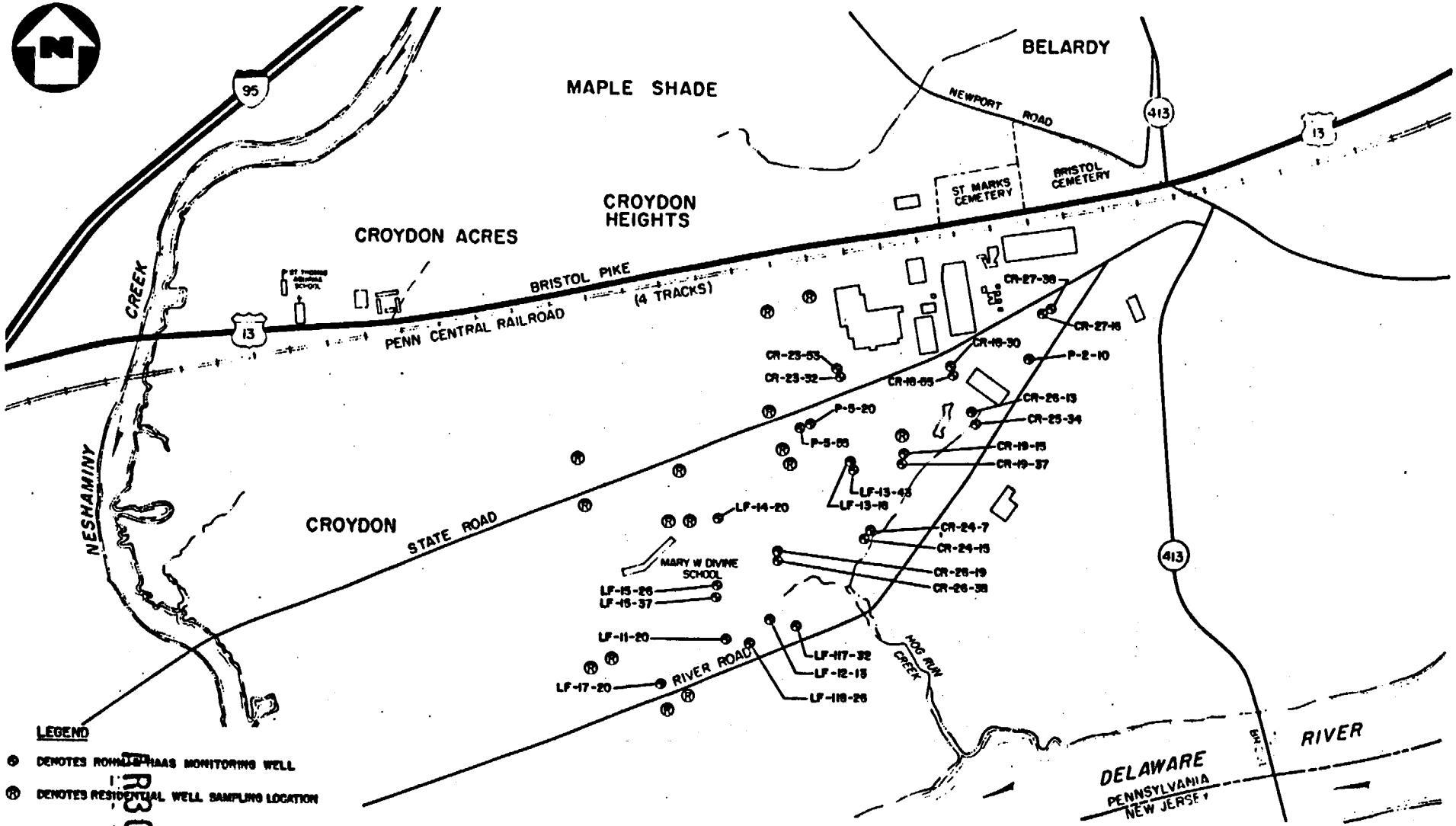
The location of residential well samples collected by BCM in 1984 are also shown in Figure 3-2. Table 3-4 lists the compounds that have been found in the residential well samples and the concentration range within which they were reported.

Air

No air sampling has been conducted within the study area to date.

3.2 PRELIMINARY RISK ASSESSMENT

A preliminary risk assessment was performed to determine the nature and extent of the potential threat to human health and the environment from the Croydon TCE Site. This assessment was based on the available data generated by BCM for Rohm & Haas during its investigation of groundwater contamination beneath the Rohm & Haas property. The BCM reports (1984a,b; 1985; 1986a,b,c,d) and the EPA Hazard Ranking System (HRS) provided information on chemical analyses and on the study area. The information provided in these reports is extensive. Therefore, only data relating to the study area, and not the Rohm & Haas Manufacturing or landfill areas, were used to perform a preliminary risk assessment.



LEGEND

- ⊕ DENOTES ROHM & HAAS MONITORING WELL
- Ⓡ DENOTES RESIDENTIAL WELL SAMPLING LOCATION

R300027

FIGURE 3-2

MONITORING WELL & RESIDENTIAL WELL LOCATIONS
CROYDON TCE SITE, BUCKS COUNTY, PA

SCALE IN FEET

NUS CORPORATION

030027

TABLE 3-1

SURFACE WATER CONTAMINANTS
CROYDON TCE SITE

Compound	Range
Trichloroethene	1.1-30 µg/l
Benzene	4.0-31.2 µg/l
1,1-Dichloroethane	2.6 µg/l
1.1-Dichloroethene	1.1 µg/l
Tetrachloroethene	1.0-1.8 µg/l
1,1,1-Trichloroethane	0.9-7.3 µg/l
Ethylbenzene	316-374 µg/l
Methylene Chloride	5.9 µg/l
Toluene	1.3 µg/l
1,2-Dichloroethane	1.0 µg/l
Bis(2-chloroisopropyl) ether	21 µg/l

TABLE 3-2

SEDIMENT CONTAMINANTS
CROYDON TCE SITE

Compound	Range (µg/kg)
Trichloroethene	10 - 11
Methylene Chloride	15 - 480
Phenanthrene	500 - 1,600
Anthracene	230 - 310
Fluoranthene	420 - 2,200
Pyrene	320 - 1,700
Benzo(a)anthracene	1,100 - 1,200
Chrysene	1,000 - 1,100
Benzo(b)fluoranthene	860 - 1,400
Benzo(k)fluoranthene	220 - 940
Benzo(a)pyrene	1,100 - 1,800
Indeno(1,2,3-c,d)pyrene	1,600
Dibenzo(a,h)anthracene	540
Benzo(g, h, i)perylene	1,500
Lead	2,990 mg/kg

TABLE 3-3

GROUNDWATER CONTAMINANTS - MONITORING WELLS (µg/l)
CROYDON TCE SITE

Monitoring Well No.:	CR-7-20	CR-18-30	CR-18-55	CR-19-15	CR-19-37	CR-24-7	CR-24-15	CR-26-19	CR-26-38
Compound									
Trichloroethene	2.8	3.6-55.4	4.7-98.7	10.8-79.1	16-522	58.4-146	1.3-2.5	3.7-4.3	378-414
1,1,1-Trichloroethane	0.1		2.4-25.4	2.1-26.6	14.8-130				
Tetrachloroethene			25.7	2.3-193	3.4				
1,1-Dichloroethene				2.3					
Ethylbenzene					2.6				
Toluene									
Total Xylenes			1.6		7.1				
Bis-(2-ethylhexyl) phthalate									
Di-n-octyl phthalate									
Chloroform	37.8		2.4	2.6-3	0.8				
1,1-Dichloroethane					10.7				
trans-1,2-Dichloroethene									
Cis-1,3-Dichloropropene									

TABLE 3-3
GROUNDWATER CONTAMINANTS - MONITORING WELLS (µg/l)
CROYDON TCE SITE
PAGE TWO

Monitoring Well No.:	CR-27-18	CR-27-38	CR-25-13	CR-25-34	CR-23-32	CR-23-53	LF-13-18	LF-13-43	LF-14-20
Compound									
Trichloroethene	3.9	-	7.7-60.5	14.2-17.6	3.3	33.2-33.3	107-230	129-341	1.0
1,1,1-Trichloroethane							19.4-45	37.1-49	
Tetrachloroethene							1.7-1.8	1.2-2.9	218
1,1-Dichloroethene							1.1	4.3-8.1	
Ethylbenzene									
Toluene									
Total Xylenes									
Bis-(2-ethylhexyl) phthalate									65
Di-n-octyl phthalate									
Chloroform									
1,1-Dichloroethane								0.3-1.7	
trans-1,2-Dichloroethene							0.5	0.5	
Cis-1,3-Dichloropropene							5.5-12		

TABLE 3-3
GROUNDWATER CONTAMINANTS - MONITORING WELLS (µg/l)
CROYDON TCE SITE
PAGE THREE

Monitoring Well No.:	LF-15-26	LF-15-37	LF-11-20	LF-12-13	Overall Range
Compound					
Trichloroethene					1.0-522
1,1,1-Trichloroethane					0.1-130
Tetrachloroethene		16.5			1.7-218
1,1-Dichloroethene					1.1-8.1
Ethylbenzene					2.6
Toluene			5.2		5.2
Total Xylenes			15.3		1.6-15.3
Bis-(2-ethylhexyl) phthalate	31	90		54	31-90
Di-n-octyl phthalate	11				11
Chloroform					0.8-37.4
1,1-Dichloroethane					0.3-10.7
trans-1,2-Dichloroethene					0.5
Cis-1,3-Dichloropropene					5.5-12
		82			8.2

Note: Blank space indicates compound not found above detection limits.

TABLE 3-4

GROUNDWATER CONTAMINANTS -
RESIDENTIAL WELLS
CROYDON TCE SITE

Compound	
Organics	Range (µg/l)
Trichloroethene	0.3-30.1
Tetrachloroethene	0.3-3.8
1,1-Dichloroethane	0.9
1,2-Dichloroethane	0.3-22.5
1,1,1-Trichloroethane	1.1-10.9
Trans-1,2-dichlorethene	5.5-6.7
Chloroform	0.3-3.7
Methylene Chloride	0.7-5.9
Vinyl Chloride	9.4
Ethylene Dichloride	0.3-0.5
Inorganics	Range (mg/l)
Arsenic	0.001-0.025
Cadmium	0.0021-1.14
Lead	0.003-0.005
Zinc	0.02-1.69
Copper	0.03-0.62
Mercury	0.0013

Human exposure to the chemicals present at the Croydon TCE Site in environmental media (i.e., soil, air, groundwater, and surface water) were determined using conservative assumptions.

Conservative assumptions tend to overestimate exposure so that the final estimate of exposure will be near or higher than the upper end of the range of actual exposures.

This preliminary risk assessment only qualitatively discusses the potential threat to human health and the environment. A quantitative risk assessment will be performed as part of the RI/FS. One of the purposes of a preliminary assessment is to identify possible pathways and receptors. An exposure pathway is complete if four elements are present: (1) source and mechanism of chemical release to the environment, (2) environmental transport medium (e.g., groundwater, surface water), (3) point of potential contact with the contaminated medium (the point) and (4) an exposure route at the contact point. These elements will be discussed in the following subsections.

3.2.1 Migration Pathways

A migration pathway describes the movement of a compound or compounds from a source to a receptor. One of the limitations of this preliminary risk assessment is that the source of groundwater contamination at the Croydon TCE Site has not been determined or characterized. Thus, the following discussion can only identify potential pathways. It should be noted that upon completion of the field investigation, a more specific discussion will be presented as part of the quantitative risk assessment.

The migration of contaminants that have been released in the past and may be released in the future from the "as yet to be identified sources" in the area is influenced by (1) site environmental factors, (2) waste characteristics, and (3) the physical and chemical properties of the chemicals found in the environmental media at the site. The groundwater at the Croydon TCE Site is known to be contaminated with TCE, PCE, and various other volatile organics. The contaminants present in the groundwater may be released into the surface water bodies in the study area. If the groundwater were used for household uses, the volatile organics would be released into the air.

3.2.2 Chemicals of Concern

A number of compounds have been detected in the groundwater adjacent to the Rohm & Haas facility. Among these are included several potentially carcinogenic compounds: arsenic, chloroform, 1,2-dichloroethane, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride. These compounds may also be detected during groundwater sampling as part of the current RI/FS, therefore, a brief description of the

health effects associated with these compounds will be presented in this section. This description can be correlated with Table 3-5, which compares the existing data with the health-based Applicable Relevant and Appropriate Requirements (ARARs).

Arsenic is a known human carcinogen and has been found to increase the incidence of skin and lung cancers in humans (EPA, 1984a). Chloroform has been found to be carcinogenic by the oral route in rodents as seen by an increase in liver and kidney tumors; human data are limited but chloroform is a suspected human carcinogen (EPA, 1984b). 1,2-Dichloroethane has been found to increase hemangiosarcomas in male rats following oral exposure; human data are lacking but it is a suspected human carcinogen (EPA, 1984c). Methylene chloride is classified as a suspected human carcinogen based on animal studies which showed an increased incidence of salivary gland sarcomas (EPA, 1984d). Tetrachloroethene (PCE) is a suspected human carcinogen which was found to cause an increased incidence of hepatocellular carcinomas in mice; data derived from human studies were inadequate to assess carcinogenic risks associated with exposure to tetrachloroethene (EPA, 1984e). Trichloroethene (TCE) was shown to cause an increased incidence of hepatocellular carcinoma in mice; human epidemiological studies have not demonstrated a relationship between exposure to trichloroethene and cancer (EPA, 1984f). However, for this study, TCE and PCE will be evaluated as carcinogens when assessing health risks. Vinyl chloride has been found to be carcinogenic in humans based on studies linking inhalation exposure with an increase in liver, kidney, lung and brain tumors (EPA, 1984g).

3.2.3 Exposure Pathways

The purpose of this section is to identify potential exposure pathways that may be quantified during the RI.

Groundwater

A number of inorganic and organic compounds were detected in the groundwater at the Croyden TCE Site. Data from background monitoring wells were not available so it is not known whether or not the inorganics are present due to natural sources or are the result of human activity. Several exposure scenarios can be developed to assess the potential risk to individuals using the groundwater. These may include ingestion of the groundwater as the sole source of drinking water, inhalation of volatiles released while using the water for showering or bathing, washing clothes or dishes, watering plants, cooking or any other activity which involves the use of water, or ingestion of vegetables irrigated with the contaminated groundwater. As part of the RI/FS, any exposure pathways which are complete will be quantified.

TABLE 3-5

COMPARISON OF EXISTING DATA AND ARARS
CROTON TCE SITE

Constituent	Maximum Concentration Detected (ug/l)			NPDWR (ug/l)(4)		Health Advisories (ug/l)(4)		AWQC			
								Aquatic Life (ug/l)(5)		Human Health (ug/l)(4)	
	EW (1)(2)	EW (3)	MW (6)(7)(8)	MCLs/ PMCLs	MCLGs/ PMCLGS	Child	Adult	Acute	Chronic	Ingestion of Drinking Water and Aquatic Life	Ingestion of Drinking Water
trichloroethene	30.1	38	522	5(A)	0(B)	-	-	2,000	-	0(2.7)*	0(2.8)*
tetrachloroethene	3.8	1.8	218	-	0(B)	10 day: 34,000 long term: 1,940	long term: 6,000	5,280	840	0(0.8)	0(0.88)*
1,1,1-trichloroethane	10.9	7.3	130	200(A)	200(B)	1 day: 140,000 10 day: 35,000 long term: 35,000	long term: 125,000 lifetime: 1,000	18,000	-	18.4 mg/l	19 mg/l
1,1-dichloroethane	8.9	2.6	8.5	-	-	-	-	-	-	-	-
1,1-dichloroethene	ND	1.1	8.1	7(A)	-	-	-	11,600	-	0(33 mg/l)	0(33 mg/l)
trans-1,2-dichloroe-thene	6.7	ND	12	-	70(A)	1 day: 2,700 10 day: 1,000 long term: 1,000	long term: 3,500 lifetime: 350	11,600	-	-	-
1-2-dichloroethene	22.9	1.0	ND	5(A)	0(B)	1 day: 740 10 day: 740 long term: 740	long term: 2,600	118,000	20,000	0(9.4)*	0(9.4)*
chloroform	3.7	<1	10.7	-	-	-	-	28,900	1,240	0(0.19)*	0(0.19)*

TABLE 3-5
COMPARISON OF EXISTING DATA AND ARARS
CROYDON TCE SITE
PAGE TWO

Constituent	Maximum Concentration Detected (ug/l)			NPDWR (ug/l)(4)		Health Advisories (ug/l)(4)		AWQC			
								Aquatic Life (ug/l)(5)		Human Health (ug/l)(4)	
	DW (1)(2)	SW (3)	MW (6)(7)(8)	MCLs/ PMCLs	MCLGs/ PMCLGS	Child	Adult	Acute	Chronic	Ingestion of Drinking Water and Aquatic Life	Ingestion of Drinking Water
methylene chloride	5.9	5.9	ND	-	-	1 day: 13,300 10 day: 1,500	-	11,000	-	0(0.19)*	0(0.19)*
vinyl chloride	9.4	ND	ND	1(A)	0(B)	1 day: 2,600 10 day: 2,600 long term: 13	long term: 46	-	-	0(2.0)*	0(2.0)*
benzene	ND	31.2	ND	5(A)	0(B)	1 day: 233 10 day: 233	-	5,300	-	0(0.66)*	0(0.67)*
chlorobenzene	ND	<1	ND	-	-	1 day: 1,000 10 day: 1,000 long term: 9.000	long term: 300,000 lifetime: 3,150	250	50	488	488
cadmium	1,140	NA	NA	10(B)	-	1 day: 43 10 day: 8 long term: 5	long term: 10 lifetime: 10	**	**	10	10
ethylbenzene	ND	374	2.6	-	680(A)	1 day: 21,000 10 day: 2,100	lifetime: 3,400	32,000	-	1,400	2,400
toluene	ND	1.3	9.2	-	2000(A)	1 day: 10,000 10 day: 6,000	lifetime: 10,000	17,500	-	14,300	15,000

TABLE 3-5
COMPARISON OF EXISTING DATA AND ARARS
CROYDON TCE SITE
PAGE THREE

Constituent	Maximum Concentration Detected (µg/l)			NPDWR (µg/l)(4)		Health Advisories (µg/l)(4)		AWQC			
								Aquatic Life (µg/l)(5)		Human Health (µg/l)(4)	
	DW (1)(2)	SW (3)	MW (6)(7)(8)	MCLs/ PMCLs	MCLGs/ PMCLGS	Child	Adult	Acute	Chronic	Ingestion of Drinking Water and Aquatic Life	Ingestion of Drinking Water
bis(2-chloroisopropyl) ether	ND	21	ND	-	-	-	-	238,000	-	0(30 ng/l)*	0(30 ng/l)
ethylene dichloride	0.5	ND	ND	-	0(A)	-	-	-	-	-	-
arsenic	25	NA	NA	50(B)	50(A)	1 day: 50 10 day: 150 longer term: 50	longer term: 50 lifetime: 50	440	-	0(2.2 ng/l)*	0(25 ng/l)*
lead	5	NA	NA	50(B)	20(A)	longer term: 20µg/day	longer term: 20µg/day	**	**	50	50
zinc	1,690	NA	NA	-	-	-	-	47	**	5000+	5000+
copper	620	NA	NA	-	1300(A)	-	-	**	**	1000+	1000+
mercury	1.3	NA	NA	2(B)	3(A)	-	lifetime: 5.5	2.4	0.012	144 ng/l	18

DW - Domestic Wells
MW - Monitoring Wells
SW - Surface Water
NPDWR - National Primary Drinking Water Regulations
MCLs - Maximum Contaminant Level (µg/l)
PMCL - Proposed MCL
MCLG - Maximum Contaminant Level Goal (µg/l)
PMCLG - Proposed MCLG
AWQC - Ambient Water Quality Criteria (µg/l)

ND - Not Detected
(A) - Proposed
(B) - Final
NA - Not Analyzed

* - AWQC is zero. The value corresponds to a 1×10^{-6} lifetime cancer risk.
** - Criterion dependent on water hardness
+ - Organoleptic (taste and odor) effects
(#) - Sources (1) BCM, 1984a
(2) BCM, 1984b
(3) NUS Corp., 1985
(4) USEPA, 1986a and 1986b
(5) USEPA, 1980
(6) BCM, 1986a
(7) BCM, 1986b
(8) BCM, 1986c

Surface Water

There are a number of surface water bodies in the study area that could be affected by contaminants being released from the site. These surface waters are Neshaminy Creek, Hog Run Creek and its tributaries, the Delaware River, and several unnamed streams and ponds. Exposure to individuals could occur while swimming or wading in contaminated water or sediments, by inhalation of volatiles released from the water, or through ingestion of contaminated fish. Exposure to biota living in or near the surface water bodies could also occur. As part of the RI, the water quality of the surface water bodies will be determined. The uses of these surface water bodies will also be determined so that realistic exposure scenarios can be quantified as part of the risk assessment.

Soil

It is not known whether or not the surface soils at the site are contaminated. Surface soil samples were collected during Rohm & Haas' investigation near the Mary Devine School and at the baseball fields adjacent to the school. No elevated levels of contaminants were reported for these samples. Based on this limited amount of data, there does not appear to be extensive surface soil contamination. However, additional samples will be collected during the Phase I RI in order to assess all exposure routes for this pathway. If the field investigation reveals that there is soil contamination at the site, then an exposure scenario involving dermal contact and incidental ingestion of the contaminated soils would be performed. Additionally, if volatile organic compounds are detected in surface soils it is possible that they would be released to the air as vapors. Therefore, this pathway would also be quantified.

Air

It is not known whether or not the outdoor air pathway is complete; the indoor air pathway is complete. The indoor air pathway is complete since an individual using contaminated groundwater in the home would be exposed to volatile organics that could be released from the water. The surface water bodies or soils could be a source of volatile organics to the air. Data are not available to determine whether or not these are accurate assumptions. If the sampling data reveal that there are volatile organics present in the surface water or soils then these pathways would be quantified during the risk assessment.

3.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

One of the primary concerns in the development of remedial action alternatives for sites governed by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is the degree of public health or environmental protection afforded by each remedy. EPA policy states that in the process

of developing and selecting remedial action alternatives, primary consideration should be given to actions that attain or exceed Applicable or Relevant and Appropriate Requirements (ARARs), as defined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA). The purpose of this requirement is to make CERCLA response actions consistent with other pertinent Federal and state environmental requirements.

SARA (Section 121) defines an ARAR as

- Any standard, requirement, criteria, or limitation under Federal environmental law.

- Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than the associated Federal standard, requirement, criteria, or limitation.

Applicable requirements are Federal public health and environmental requirements that would be legally applicable to a remedial action if that action was not undertaken pursuant to CERCLA. For example, if hazardous waste activities were undertaken pursuant to an approved permit, applicable regulations would be available to legally define the required remedial action for site closure. Relevant and appropriate requirements are Federal public health and environmental requirements that apply to circumstances sufficiently similar to those encountered at CERCLA sites, where their application would be appropriate although not legally required. In addition, SARA now requires that state ARARs be considered during the assembly of remedial alternatives if they are more stringent than Federal requirements. EPA has also indicated that "other" criteria, advisories, and guidelines must be considered in devising remedial alternatives.

A detailed listing of the preliminary Federal and Commonwealth of Pennsylvania ARARs identified for the Croydon TCE Site is provided in Tables 3-6 and 3-7, respectively (A description of each ARAR is given in Appendix A). The ARARs identified in these tables will be evaluated in terms of their applicability, relevance, and appropriateness. The ARARs will be considered at five decision points during the RI/FS. These include

1. Task 6 - Public Health Evaluation: Consider health-based ARARs during the analysis of the risks to public health and the environment. Table 3-5 compares the maximum concentrations of organic and inorganic constituents detected in groundwater and surface water samples to health-based ARARs. Most of the contaminants exceed the National Primary Drinking Water Regulations (NPDWR) and/or Ambient Water Quality Criteria (AWQC).

TABLE 3-6

PRELIMINARY LISTING OF
FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
CROYDON TCE SITE

Requirement	Rationale
1. Hazardous Waste Requirements (RCRA Subtitle C, 40 CFR, Part 264)	Standards applicable to treating, storing and disposing of hazardous waste.
2. Safe Drinking Water Act	
a. Maximum Contaminant Levels (MCLs)	Remedial actions may provide clean up to the MCLs.
b. Maximum Contaminant Level Goals (MCLGs)	SARA Section 121(d)(2)(A)(ii)*
c. Underground Injection Control Regulations (40 CFR, Parts 144, 145, 146, and 147)	May be applicable to onsite groundwater recirculation systems.
3. Toxic Substances Control Act (15 U.S.C. 2601). TSCA health data, chemical advisories, and Compliance Program policy.	Considered in the public health evaluation.
4. Health Advisories, EPA Office of Drinking Water	RI activities identified presence of chemical for which health advisories are listed. *
5. Clean Water Act (PL92-500)	
a. State water quality standards (PA Code Title 25, Chapter 95)	Remedial actions may include discharge to surface waters.
b. Federal water quality criteria (FWQC)	Remedial actions may provide groundwater remediation and discharge to surface waters.*
c. NPDES permit	Remedial alternatives may include discharge to surface waters.
6. Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR, Part 230)	Remedial alternatives at site may potentially include dredging and filling in wetlands.

AR300041

TABLE 3-6
PRELIMINARY LISTING OF
FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
CROYDON TCE SITE
PAGE TWO

Requirement	Rationale
7. Rivers and Harbors Act of 1899 33 CFR Parts 320-327	Remedial alternatives at site may affect the Delaware River.
8. Dredged Material Disposal Sites Denial or Restriction Procedures (404(c); 40 CFR, Part 231)	Remedial alternatives at site may include dredging and filling in wetlands.
9. Regulation of Activities Affecting Water of the U.S. (33 CFR, Parts 320-329)	Corps of Engineers regulations apply to both wetlands and navigable waters (Section 10, Waters).
10. Clean Air Act (42 USC 7401)	
a. National Ambient Air Quality Standards (NAAQS) for six criteria pollutants (40 CFR Part 50)	Remedial alternatives may include incineration or groundwater volatilization technologies.
b. Public health basis to list pollutants as hazardous under Section 112 of the Clean Air Act	Remedial alternatives may include incineration or groundwater volatilization technologies.
11. OSHA Requirements (29 CFR, Parts 1910, 1926, and 1904)	Required for workers engaged in onsite remedial activities.
12. Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands)	Both floodplain and wetland resources may be affected by the site remedial alternatives.
13. DOT Rules for Hazardous Materials Transport (49 CFR, Parts 107, 171.1-171.500)	Remedial alternatives may include offsite treatment and disposal.
14. Endangered Species Act of 1978 (16 USC 1531)	Considered in the public health and environmental assessment.
15. Fish and Wildlife Coordination Act (16 USC 661)	Remedial alternatives may affect wetlands and protected habitats.
16. Fish & Wildlife Improvement Act of 1978 (16 USC 742)	Remedial alternatives may affect wetlands and protected habitats.

TABLE 3-6
PRELIMINARY LISTING OF
FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
CROYDON TCE SITE
PAGE THREE

Requirement	Rationale
17. Fish & Wildlife Conservation Act of 1980 (16 USC 2901)	Remedial alternatives may affect wetlands and protected habitats.
18. Pesticide Registration, Tolerances and Action Levels	Pesticides are presently not considered site contaminants.
19. Health Effects Assessments	Considered in the public health risk assessment included in RI report.*
20. EPA's Groundwater Protection Strategy	Remedial alternatives must consider EPA classification of groundwater conditions at site.
21. General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR Part 403).	Considered for remedial alternatives involving pretreatment of groundwater prior to treatment at a POTW.

Source: 50 Federal Register 224, Wednesday, November 20, 1985.

* To be considered

AR300043

TABLE 3-7

COMMONWEALTH OF PENNSYLVANIA
APPLICABLE OR RELEVANT AND APPROPRIATE STATE REQUIREMENTS
CROYDON TCE SITE

Requirement	Rationale
1. Pennsylvania Solid Waste Disposal Regulations, PA Code Title 25, Chapter 75	Standards for treating, storing, and disposing of hazardous wastes.
2. Pennsylvania Pollutant Discharge Elimination System (NPDES) Rules, PA Code Title 25, Chapter 92	Remedial actions may include discharge to surface waters.
3. Pennsylvania Water Quality Standards, PA Code Title 25, Chapter 93	Remedial actions may include discharge to surface waters.
4. Pennsylvania Wastewater Treatment Requirements, PA Code Title 25, Chapter 95	Remedial actions may include discharge to surface waters.
5. Pennsylvania Industrial Waste Regulations, PA Code Title 25, Chapter 97	Remedial actions may include discharge to surface waters.
6. Pennsylvania Special Water Pollution Regulations, PA Code Title 25, Chapter 101	Applicable for permitted solid waste disposal facilities.
7. Pennsylvania Air Pollution Control Regulations, PA Code Title 25, Chapters 121 through 143	Incineration is considered a potential remedial action.
8. Pennsylvania Storm Water Management Act of October 4, 1978, Act No. 167	Remedial actions may require stormwater management systems.
9. Pennsylvania Erosion Control Regulations, PA Code Title 25, Chapter 102	Soil disturbances during proposed remedial actions may require erosion and sedimentation control measures.
10. Pennsylvania Hazardous Substances Transportation Regulations PA Code Title 13 (Flammable Liquids and Flammable Solids) and Title 15 (Oxidizing Materials, Poisons, and Corrosive Liquids)	Applicable to wastes shipped offsite for analysis, treatment, or disposal.

TABLE 3-7
COMMONWEALTH OF PENNSYLVANIA
APPLICABLE OR RELEVANT AND APPROPRIATE STATE REQUIREMENTS
CROYDON TCE SITE
PAGE TWO

Requirement	Rationale
11. Pennsylvania Wild and Scenic Rivers Act, Act of December 5, 1972, Act No. 283	Considered in the public health and environmental assessment. Remedial actions may include discharge to the Hog Run Creek or Deleware River.
12. Rare and Endangered Species Regulations PA Code Title 58	Considered in the public health and environmental assessment.

Source: Pennsylvania Environmental Research Foundation, Inc. 1980

AR300045

2. Task 9 - Development of Remedial Objectives: Compare site data base to health-based and location-specific ARARs.

3. Task 9 - Identification of Applicable Technologies and Assembly of Alternatives: Utilize ARARs specific to site conditions for development of action levels, specific response objectives, and remedial alternatives relative to criteria defined in 40 CFR 300.68(f). Also, identify ARARs that apply to the formulated alternatives.

4. Task 9 - Screening of Remedial Technologies/Alternatives: Consider health-based ARARs when assessing the effectiveness of an alternative, as defined in 40 CFR 300.68(g)(3).

5. Task 10 - Remedial Alternatives Evaluation: Evaluate each alternative to the extent it attains or exceeds ARARs, as defined in 40 CFR 300.68(h)(2)(iv).

3.4 PRELIMINARY SCOPING OF REMEDIAL ALTERNATIVES

Because the source(s) of the groundwater and surface water contamination has not identified or characterized, potential source control measures cannot be identified in the Phase I RI/FS. Data will be collected during the Phase I RI to help locate potential source areas and source control measures will be evaluated once the source(s) is known. A limited number of management of migration measures have been identified for the Croydon TCE Site. These measures are outlined on Table 3-8. Based on the site problem (volatile organic contaminants in the groundwater), it is probable that certain onsite and offsite treatment technologies (i.e., groundwater pumping and air stripping) will be considered during the evaluation of remedial alternatives.

The proposed data collection activities, which are described in Section 3.7, will provide information to evaluate these measures. Additional management of migration measures will be evaluated during the Phase I RI and FS.

SARA emphasizes risk reduction through destruction or detoxification of hazardous waste by employing treatment technologies which reduce toxicity, mobility, or volume rather than protection that is achieved through prevention of exposure (Porter, 1986). In addition, SARA emphasizes that remedial alternatives focus on permanent solutions which reduce or eliminate the need for long-term management, treatment technologies, and resource recovery alternatives to the maximum extent practicable. Applicable technologies and remedies to meet the requirements of SARA will be evaluated once the source(s) of contamination is located and defined. At this

TABLE 3-8

GENERAL RESPONSE ACTIONS
AND PRELIMINARY REMEDIAL TECHNOLOGIES FOR THE PHASE I RI/FS
CROYDON TCE SITE

General Response Actions	Preliminary Remedial Technologies	Remarks
No Action	Short/Long-Term Monitoring	No action will be evaluated in accordance with SARA.
Pumping	Groundwater Pumping	Data will be collected to gain information on aquifer characteristics.
Onsite Treatment	Biological Degradation, Chemical Degradation, Physical Treatment	Data will be obtained to characterize groundwater quality. However, technologies cannot be fully evaluated until contaminant source(s) is defined.
Offsite Treatment	Biological Degradation, Chemical Degradation, Physical Treatment	Data will be obtained to characterize groundwater quality. However, technologies cannot be fully evaluated until contaminant source(s) is defined.
Alternate Water Supply	Municipal Water System	Most of the study area is served by a public water system. This response action may be feasible.

TABLE 3-9

DATA LIMITATIONS/REQUIREMENTS AND UTILIZATION
CROYDON TCE SITE

Media	Data Limitations/Requirements	Utilization			Data Collection Period	
		Source Delineation	Risk Assessment	Feasibility Study	Phase I RI	Phase II RI
Hazardous Waste(s)	• Location	X	X	X	X	X
	• Amount (Volume and Mass)	X		X		X
	• Physical Characteristics		X	X		X
	• Chemical Characteristics		X	X		X
Groundwater	• Aerial extent of known contaminant plume	X	X	X	X	
	• Groundwater quality throughout entire study area		X	X	X	X
	• Groundwater users		X	X	X	X
	• Groundwater flow patterns and rates		X	X	X	X
	• Geologic conditions		X	X	X	X
	• Hydraulic characteristcs of the alluvial aquifer		X	X	X	X
	• Interaction between surface waters and groundwater		X	X	X	
	• Background groundwater quality		X	X	X	

TABLE 3-9
DATA LIMITATIONS/REQUIREMENTS AND UTILIZATION
CROYDON TCE SITE

PAGE TWO

Media	Data Limitations/Requirements	Utilization			Data Collection Period	
		Source Delineation	Risk Assessment	Feasibility Study	Phase I RI	Phase II RI
Soils	• Physical Characteristics			X		X
	• Chemical Characteristics	X	X	X	X	X
Surface Water and Sediments	• Quality of Neshaminy Creek, Hog Run and intermittent streams		X	X	X	
	• Impact on Delaware River		X		X	
	• 100-Year Floodplain			X	X	
Biota	• Impact on biota in Neshaminy Creek, Hog Run and intermittent streams		X			X*

* Biota studies will be considered following the review and evaluation of surface water and sediment samples. If necessary, a biota investigation will be conducted during the Phase II RI.

time, innovative technologies for remediating the wastes will be explored and carried through the screening process.

3.5 DATA LIMITATIONS/REQUIREMENTS

This section summarizes the data that is necessary to meet the overall objectives for performing a remedial investigation and feasibility study at the Croydon TCE Site. The required data were identified by reviewing the existing data base and then determining the data needed to adequately assess the risks to the public health and environment, and to evaluate the feasibility of remedial alternatives. Table 3-9 provides a summary of data limitations/requirements, and the specified end uses of the data (i.e., risk assessment, feasibility study, etc.). The period of data collection (i.e., Phase I RI or Phase II RI) is also given in this table.

3.6 SPECIFIC REMEDIAL INVESTIGATION AND FEASIBILITY STUDY OBJECTIVES

This section presents the specific RI/FS objectives for the first phase of this study. As mentioned previously, the specified RI/FS objectives for the second phase of the study will be established as data are collected during the Phase I RI, and will be finalized at the conclusion of the Phase I RI. Because of the nature of this project (i.e., the combination of the size of the study area and the fact that the source of the contamination is unknown), a second Work Plan (Phase II RI/FS Work Plan) will be prepared following the Phase I RI. This Work Plan will be submitted with the Phase I RI Report and will contain the RI/FS objectives for the Phase II study.

The specific Phase I RI/FS objectives and rationale for the Croydon TCE Site are summarized in Table 3-10. The criteria for meeting these objectives and the Data Quality Objectives (DQOs) are discussed in the following section.

3.7 DATA QUALITY OBJECTIVES

Table 3-11 outlines the criteria for meeting each of the specific Phase I RI/FS objectives, the data gathering activities to meet the objectives, and the Data Quality Objectives (DQOs) for each data collection activity. DQOs are established to ensure that the data collected are sufficient and of adequate quantity and quality for their intended uses (USEPA, 1987). The DQOs in this section focus on the rationale for selecting sampling locations and analytical options. Specifically, the DQOs identified in Table 3-11 were determined based on the end use of the data to be collected. However, this section does not document the PARCC parameters (precision, accuracy, representativeness, completeness and comparability). The PARCC parameters, which are indicators of data quality, are presented in the Field Operations Plan (FOP).

TABLE 3-10

SPECIFIC PHASE I RI/FS OBJECTIVES
CROYDON TCE SITE

Specific Phase I RI/FS Objectives	Rationale
1. Characterize the nature and extent of groundwater contamination, which was previously detected in the southeastern portion of the study area.	• Review of existing data (BCM studies for Rohm & Haas) indicate that groundwater contamination has been detected in domestic wells and monitoring wells north of River Road. No groundwater data exists for the area north of State Road (see Figure 2-2).
2. Assess the public health and environmental risks posed by groundwater contamination within the study area.	• Present concentrations of organic and inorganic contaminants detected in domestic wells exceed EPA criteria (ARARs). • Some homes within the study area do not have the services of a public water supply. • No source of contamination has been determined. Unknown groundwater "hot spots" may exist in addition to the known area of contamination, which exists in the southeastern portion of the study area.
3. Determine the quality of local surface waters in order to estimate the impact from groundwater discharged and estimate health and environmental risks associated with the use of these surface waters.	• Organics and inorganics have been detected in Hog Run Creek above ARARs. • No data exists for other surface waters within the study area.

TABLE 3-10
SPECIFIC PHASE I RI/FS OBJECTIVES
CROYDON TCE SITE

PAGE TWO

Specific Phase I RI/FS Objectives	Rationale
4. Identify potential source areas that may be contributing to the groundwater contamination which is present within the southeastern portion of the study area.	• Actual source of groundwater/surface water contamination has not been established. • Studies conducted for Rohm & Haas Company indicate that their landfill may not be the source of groundwater contamination in the Croydon community.

TABLE 3-11

CRITERIA AND DATA COLLECTION ACTIVITIES FOR MEETING THE PHASE I RI/FS OBJECTIVES
CROYDON TCE SITE

Phase I RI/FS Objectives	Criteria for Meeting Objectives	Data Collection Activities	Rationale (DQOs)
1. Characterize the nature and extent of groundwater contamination which was previously detected in the southeastern portion of the study area.	• Delineate the contaminant plume boundaries. • Determine groundwater flow rates and direction. • Determine subsurface lithology. • Determine aquifer characteristics.	• Installation of at least 29 monitoring wells at 15 well locations. • Sample each newly-installed monitoring well, following development, and analyze for TCE and PCE. (Samples will be analyzed by field GC analysis-Level II.) • Sample 19 existing wells (installed by BCM for Rohm & Haas) and 29 newly-installed wells, and analyze for volatile organics (via Modified EPA Method 624) TCL inorganics, and water quality parameters on selected wells. • Sample 40 residential wells and analyze groundwater for volatiles (via modified EPA Method 624), TCL inorganics, and water quality parameters on selected wells.	• Wells will monitor the shallow and deep portions of the alluvial aquifer. • Monitoring well and domestic well locations will help determine vertical and horizontal extent of the known groundwater plume. • Well locations, including the Rohm & Haas wells, will help determine the impact of 13 potential source areas, which were previously identified by EPIC. • Level II GC Analysis will be employed to help delineate the plume boundary during the drilling operations. PCE and TCE will be analyzed for since these contaminants were frequently detected during previous investigations.

TABLE 3-11
CRITERIA AND DATA COLLECTION ACTIVITIES FOR MEETING THE PHASE I RI/FS OBJECTIVES
CROYDON TCE SITE

PAGE TWO

Phase I RI/FS Objectives	Criteria for Meeting Objectives	Data Collection Activities	Rationale (DQOs)
1. Characterize the nature and extent of groundwater contamination detected within the southeastern portion of the study area. (Continued)	(See Page 1)	• Obtain water level measurements on newly-installed wells, and 19 BCM wells. • Perform in-situ slug tests and short-term pumping tests on newly-installed wells.	• All groundwater samples will be analyzed via Level V analysis for volatiles (Modified EPA Method 624) and TCL inorganics. A Modified EPA Method 624 will be used in order to obtain lower detection limits. The lower detection limits are needed to compare contaminant levels with ARARs. Volatile organics will be analyzed in the REM III Team mobile laboratory. Twenty percent of the samples will be forwarded to CLP for TCL organic analysis using RAS. • Aquifer testing will determine groundwater velocity, direction, and flow rates.
2. Assess the public health and environmental risks posed by groundwater within the study area.	• Determine groundwater quality of domestic well users.	• Identify domestic well users within the study area. (A questionnaire was forwarded to 482 potential well owners during the preparation of this RI/FS Work Plan. The potential well owners represented homes which were located along streets that did not have service to a public water supply). • Sample 40 domestic wells and analyze for volatiles (via Modified EPA Method 624) TCL inorganics, and water quality parameters on selected wells.	• All domestic well samples will be analyzed for volatiles (Modified EPA Method 624) at the REM III Team mobile laboratory. A Modified EPA Method 624 will provide lower detection levels in order to compare contaminant levels with ARARs. • Inorganics will be analyzed via CLP (Level IV analysis).

TABLE 3-11
CRITERIA AND DATA COLLECTION ACTIVITIES FOR MEETING THE PHASE I RI/FS OBJECTIVES
CROYDON TCE SITE

PAGE THREE

Phase I RI/FS Objectives	Criteria for Meeting Objectives	Data Collection Activities	Rationale (DQOs)
3. Determine the quality of local surface waters in order to estimate the impact from groundwater discharge and estimate health risks associated with the use of these waters.	• Identify streams of concern for risk characterization. • Determine surface water and sediment quality. • Estimate groundwater/surface water interaction.	• Conducted a site reconnaissance and reviewed site location maps to identify streams which are within or near the study area. • Sample study area surface waters (including sediments) and analyze for TCL organics and inorganics via CLP routine analytical services. • Obtain at least two complete rounds of water level measurements on monitoring wells and Hog Run Creek (via staff gauges).	• Neshaminy Creek, Hog Run Creek, Delaware River, and four intermittent streams were selected for sampling based on their location within or near the study area . • CLP routine analytical services will be employed to analyze the samples for TCL organics and inorganics (Level IV analysis).
4. Identify potential source areas that may be contributing to the groundwater contamination, which is present within the southeastern portion of the study area.	• Delineate contaminant plume(s).	• Same as objective number 1	• Same as objective number 1

The scoping of the Phase I RI/FS was conducted during a three week period following the site reconnaissance of March 24, 1987. This "brainstorming" period resulted in the development of the Phase I RI/FS objectives and the criteria to meet these objectives. Data collection activities were subsequently proposed to satisfy the criteria.

In order to satisfy the criteria for characterizing the nature and extent of the groudnwater contamination (Objective Number 1), a hydrogeologic investigation will be conducted at the southeastern portion of the study area. The hydrogeologic investigation is outlined in Section 4.3.2 of this report. Each aspect of the hydrogeologic investigation (i.e. location and number of wells, sample analysis, etc.) is discussed in Section 4.3.2. The hydrogeologic investigation will also obtain information to satisfy Objective Number 4 (Identify Potential Source Areas).

Objective Number 2 (Assess the Public Health and Environmental Risks Posed by Groundwater Within the Study Area) will be accomplished by determining the groundwater quality from domestic wells within the study area. To satisfy this criteria, a residential well survey was conducted and a sampling program will be implemented. Section 4.3.3 (Residential Well Survey/Investigation) discusses the rationale behind the proposed residential well investigation.

To meet Objective Number 3 (Determine the Quality of Local Surface Waters), a surface water and sediment investigation will be conducted. This investigation will consist of collecting surface water and sediment samples from 21 locations throughout the study area. The samples will be collected from Neshaminy Creek, the Delaware River, Hog Run Creek and its tributaries, and 3 intermittent streams (unnamed). Section 4.3.5 outlines the rationale for the various aspects of this investigation.

A more detailed description of the field investigations is given in Section 4.3 (Field Investigations).

4

4.0 TASK PLAN FOR REMEDIAL INVESTIGATION

This section identifies the tasks that will be implemented to conduct the Phase I RI/FS for the Croydon TCE Site. The RI will be comprised of Tasks 1 through 8 as defined below:

- Task 1 - Project Planning
- Task 2 - Community Relations
- Task 3 - Field Investigation
- Task 4 - Sample Analysis and Data Validation
- Task 5 - Data Evaluations
- Task 6 - Risk Assessment
- Task 7 - Treatability Study/Pilot Testing
- Task 8 - Remedial Investigation Report

The FS will be comprised of Tasks 9 through 12 as defined below:

- Task 9 - Remedial Alternatives Screening
- Task 10 - Remedial Alternatives Evaluation
- Task 11 - Feasibility Study Report
- Task 12 - Post RI/FS Support

Section 5.0 provides a detailed description of the FS tasks. The remainder of this section provides a detailed description of the RI tasks.

4.1 TASK 1 - PROJECT PLANNING

The performance of this task results in the preparation and submittal of the Work Plan Memorandum (submitted to EPA on March 17, 1987), Draft Work Plan, Draft Field Operations Plan, Final Work Plan, and Final Field Operations Plan. The activities that comprise this task are:

- Work Plan Memorandum
- Data Collection and Review
- Site Reconnaissance
- ARAR/DQO Determination (Preliminary)
- Remedial Alternatives Identification (Preliminary)
- Preliminary Risk Assessment
- RI/FS Brainstorming and Scoping Meetings
- Phase I and II Work Plan Preparation
- Field Sampling and Analysis Plan (FSAP) Preparation
- Site Management Plan (SMP) Preparation
- Health and Safety Plan (HASP) Preparation

Because of the nature of this investigation (the study area is approximately 4 square miles and the source of contamination is unknown), a two-phased RI/FS will be conducted. This "Phase I" RI/FS Work Plan describes the scope of work, schedule, and budget to conduct the Phase I RI/FS. A Phase II RI/FS Work Plan will be prepared during the Phase I field investigation and submitted to EPA with the Draft Phase I RI Report. A Phase II Field Sampling and Analysis Plan (FSAP) and Phase II Health and

Safety Plan (HSAP) will also be prepared. The Phase II FSAP and HASP will be submitted following the submittal of the Phase II RI/FS Work Plan.

4.2 TASK 2 - COMMUNITY RELATIONS

A Community Relations Plan (CRP) will be developed as part of this work assignment. The CRP will be prepared to assist the U.S. Environmental Protection Agency Region III in meeting the needs of the communities affected by the groundwater and surface water problem. The CRP will contain information gathered during onsite interviews and telephone conversations, regarding the Croydon TCE study area.

In June 1987, the REM III Team assisted the EPA in the preparation of a well-survey questionnaire to residents living within the Croydon TCE study area who are believed to still be using their domestic well. The questionnaires were accompanied by letters requesting that the recipient complete and return the questionnaires and agree to allow the EPA's contractors, Ebasco Services Incorporated and NUS Corporation, to sample their wells in the fall of 1987. Data from the questionnaires and the well-water analysis will be used in the Phase I FS to determine if there is a need to provide an alternate water supply.

The REM III Team will provide the following support during the Phase I and Phase II RI/FS:

- Preparation of 5 fact sheets.
- Participation at 3 public meetings.
- Preparation of meeting minutes.

Specifically, a public meeting will be held upon completion of the Phase I Work Plan, Phase I RI/FS Report (and Phase II Work Plan), and Phase II RI/FS. Preparation of a Responsiveness Summary will be discussed under Task 12.

4.3 TASK 3 - FIELD INVESTIGATION

This task describes the various field investigations that will be conducted to collect data for meeting the specific Phase I RI/FS objectives that were outlined previously in Section 3.6. The following field investigations will be performed as part of the Phase I RI:

- Hydrogeologic Investigation
- Domestic Well Survey/Investigation
- Surface Water and Sediment Investigation
- Soil Investigation

4.3.1 Initial Activities

4.3.1.1 Preparation of Bid Specifications and Subcontract Procurement

Under this subtask, bid specifications will be prepared and subcontractors will be procured for the preparation of a topographic map and for drilling and installation of monitoring wells. The preparation of the bid specifications was conducted in conjunction with the development of this Work Plan in order to avoid delays when procuring applicable subcontractors, upon EPA approval of this Plan I RI/FS Work Plan.

4.3.1.2 Mobilization

This subtask will consist of field personnel orientation and equipment mobilization and will be performed at the initiation of the field activities as necessary. A field team orientation meeting will be held at the NUS office to familiarize personnel with the site history, health and safety requirements, and field procedures.

Equipment mobilization may include, but will not be limited to, the setup of the following equipment:

- Field office trailer (command post)
- Mobile analytical laboratory
- Sampling equipment
- Health and safety decontamination equipment

Electrical and telephone hookups will be acquired and a local water source will be located. The mobilization/demobilization activities will provide the basis for a time- and cost-efficient field investigation. At this time, it is anticipated that the field trailer and mobile analytical laboratory will be stationed on the Rohm & Haas Company property in order to reduce the threat of vandalism.

Before any drilling is conducted, onsite underground utilities will be located by contacting the appropriate utilities (i.e., gas, electric, telephone).

4.3.2 Hydrogeologic Investigation

The goals of the hydrogeologic investigation at the Croydon TCE Site are to determine the source(s) of the known TCE contamination within the study area, define the site geology and hydrogeology beyond the current level of understanding, delineate the nature and extent of the groundwater contaminant plume, and provide data input into the risk assessment and feasibility study. The proposed hydrogeologic investigation is designed to be a first step in reaching the objectives of the Phase I RI. It should be recognized that further work may be necessary, depending on the results of this proposed program.

To date, there is a limited amount of groundwater sampling data from a few residential and groundwater monitoring wells, which indicates that groundwater in the southeastern portion of the study area has been contaminated with TCE and other compounds. The data does not pinpoint a probable source area, nor is any obvious source apparent. Historical aerial photographs of the area have been used to identify several possible sources, which will be focused on in this investigation. These potential sources are located within the southeastern part of the study area, which will be the area of emphasis for the study (see Figure 2-3).

The specific data outputs from the proposed hydrogeologic investigation will include the determination of the following:

- Nature and extent of contamination in the alluvial aquifer within the area of well installation.
- Groundwater flow patterns and rates in the southeastern portion of the study area.
- Geologic conditions within the southeastern portion of the study area.
- Hydraulic characteristics of the alluvial aquifer.
- Interaction between surface waters and groundwater within the study area.
- Background groundwater quality.

Additionally, the data generated will be used to attempt to determine the overall extent of the groundwater contaminant plume and identify potential source area(s). As stated previously, additional work beyond what is currently proposed may be necessary to positively delineate the plume extent and exact source(s).

The hydrogeologic field investigation consists of the following:

- Drilling and installation of a minimum of 29 monitoring wells.
- Field GC analysis of newly installed monitoring wells for target compounds (TCE and PCE).
- Sampling and analysis of all newly installed monitoring wells and 19 Rohm & Haas monitoring wells.
- Hydrologic testing of newly installed monitoring wells.

- Installation of five staff gauges in Hog Run Creek and its tributaries.

- Two comprehensive rounds of water level measurements from monitoring wells and staff gauges.

- Installing continuous water level recorders on selected monitoring wells.

The data obtained through the field investigation will be evaluated and combined with historical site information and available geologic/hydrogeologic publications to provide an assessment of the geologic and hydrogeologic conditions within the site area.

As described above, a total of 29 monitoring wells will be installed, depending on the results of field GC analysis of groundwater samples. Fifteen well locations have been determined at this time. Fourteen well locations will be two well cluster locations, with a water table well and a deep alluvial well in each cluster. One location will have a single well installed, as there is already one well there and only one more is needed to complete the cluster. The need for and location of the remaining wells will be determined based on field GC analytical results. The well clusters will provide data to determine lateral and vertical variations in contaminant concentrations, determine vertical flow components within the aquifer, and provide data for determining groundwater flow patterns.

The proposed monitoring wells and the location of the Rohm & Haas wells are shown in Figure 4-1. The rationale for each well location and the primary functions for each well cluster are listed in Table 4-1. The proposed well locations were selected by the REM III Team with input from EPA based on the locations of suspected source areas, the observed locations of TCE contaminated wells, the locations of existing groundwater monitoring points presently available for sampling, the overall expected groundwater flow pattern for the area, and the data requirements of the Phase I RI/FS.

Well depths are projected to be approximately 20 to 30 feet for water table wells and from 40 to 65 feet for deep alluvial wells. Drilling, well construction/installation techniques, well development, and aquifer testing methods are described in the following subsections.

During the field investigation, five staff gauges will be installed in local surface water bodies in the site area. Four staff gauges will be installed in Hog Run Creek and one installed in the small intermittent stream located north of well cluster location 13. The staff gauges will provide information to help define local surface water/groundwater interactions.

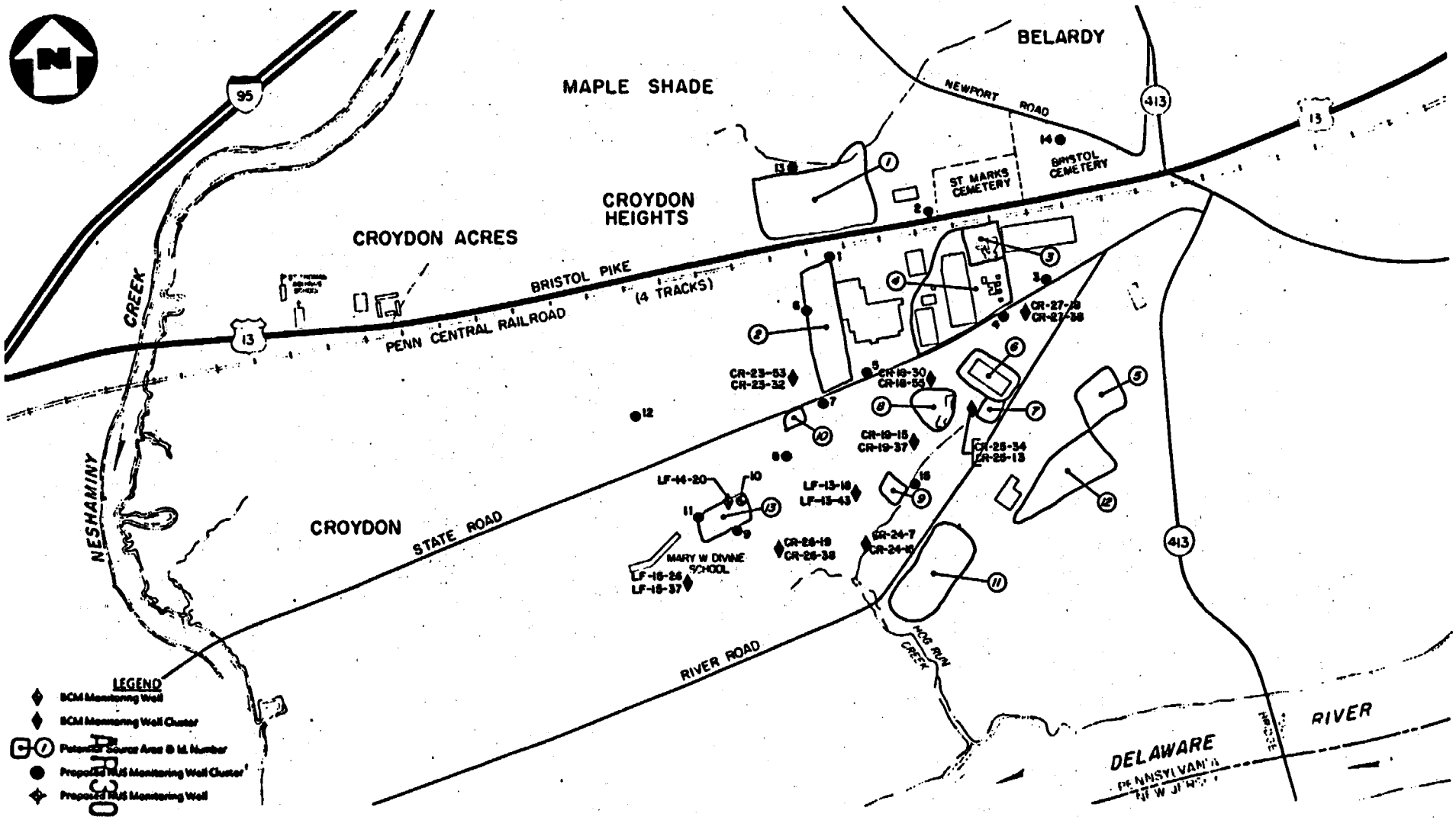


FIGURE 4-1

PROPOSED MONITORING WELL LOCATIONS
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION

TABLE 4-1

PROPOSED MONITORING WELL RATIONALE

NUS Well Location	Well Function (A = Primary, B = Secondary)					Rationale
	Cluster (C) or Single (S)	Overall Water Quality	Source Area Identification	Plume Delineation	Groundwater Flow Directions	
1	C	B	A	A	A	Upgradient well from the Owens-Illinois property--also use for source area No. 1.
2	C	B	A	A	A	Upgradient well for possible source area Nos. 3 and 4.
3	C	B	A	A	B	Downgradient of Coyne Chemical.
4	C	B	A	A	B	Downgradient well for possible source area Nos. 3 and 4.
5	C	B	A	A	B	Downgradient from Owens-Illinois.
6	C	B	A	A	B	Located adjacent to possible source area, near impacted residential wells.
7	C	B	A	A	B	Downgradient from possible source area No. 2.

TABLE 4-1
PROPOSED MONITORING WELL RATIONALE
PAGE TWO

MUS Well Location	Well Function (A = Primary, B = Secondary)					Rationale
	Cluster (C) or Single (S)	Overall Water Quality	Source Area Identification	Plume Delineation	Groundwater Flow Directions	
8	C	B	A	A	B	Upgradient of BCM wells with high TCE concentrations.
9	C	B	A	A	B	Upgradient of BCM well w/high TCE, downgradient of possible source area.
10	S	B	A	A	B	Complete well cluster with Rohm & Haas Well, adjacent to possible source area.
11	C	B	A	A	A	Upgradient from possible source area.
12	C	A	B	B	A	Overall water quality and flow directions south of Bristol Pike.
13	C	B	A	A	A	Possible downgradient of potential source area No. 1.
14	C	A	A	A	A	Assess potential groundwater contamination that would be migrating from the area which is east of Route 413.
15	C	B	B	B	A	Determine flow directions in the vicinity of Hog Run Creek. Assess the stream's influence on groundwater flow directions.

4.3.2.1 Drilling Operations

Applicable drilling methods at the Croydon TCE Site include hollow stem auger and mud rotary drilling techniques. Hollow stem auger drilling is the preferred method, with mud rotary drilling techniques used as a backup in the event cobble zones are encountered that make auger drilling ineffective. Each boring drilled will be lithologically logged by the field geologist via split-barrel samples or cuttings, depending on the drilling/sampling techniques used. A complete log of each boring will be maintained, describing lithologies, depths of contacts, water levels/water yielding zones, total depths, and any other pertinent data that may be discovered. Geologic samples will be described using the Unified Soil Classification System (USCS). Split-barrel sampling will be performed at 5-foot intervals during operations for geologic description purposes. Detailed logging procedures for samples are described in the FOP.

4.3.2.2 Well Construction/Installation

Monitoring wells will be constructed of 2-inch diameter, nonglued-flush-joint, threaded, Schedule 40 PVC casing and well screens equipped with a PVC end plug. Figure 4-2 illustrates typical well construction details for a monitoring well.

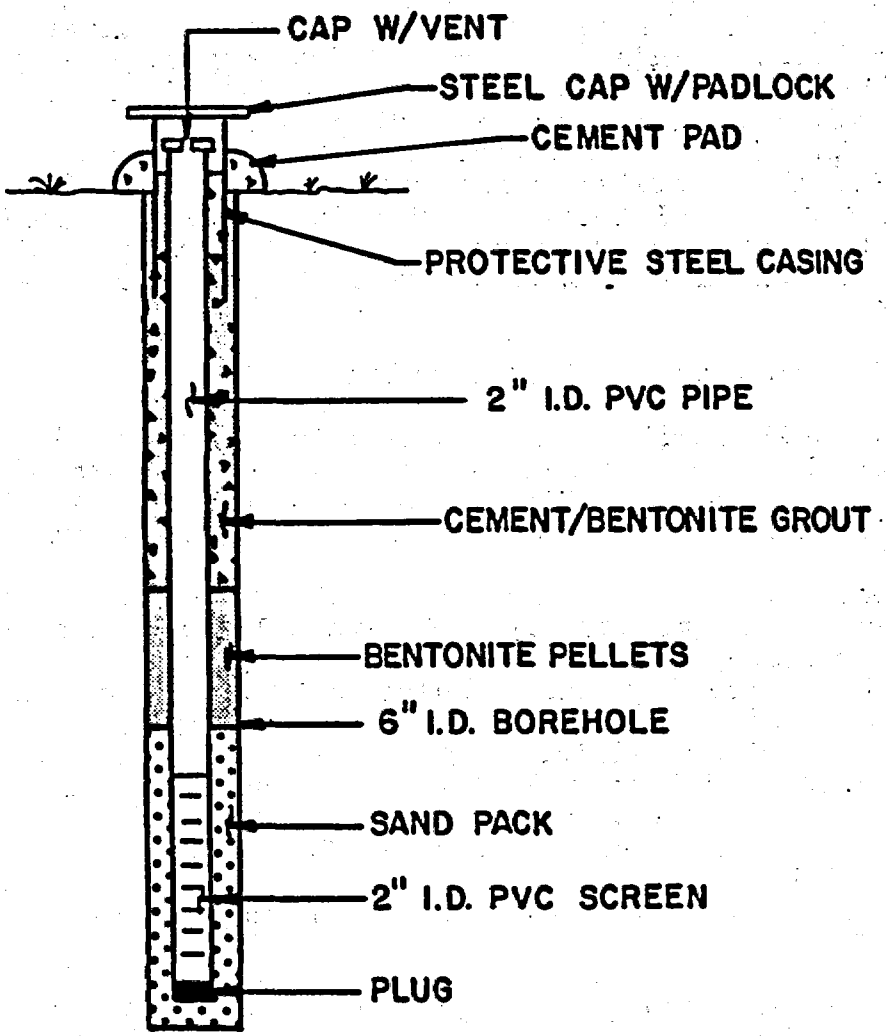
Well screens will be 10 feet in length and slot size will be 0.02 inches. The monitoring well installation procedure will consist of placing the PVC pipe and screen into the completed boring and backfilling the annulus of the boring, around the well screen, and approximately 1 to 3 feet above the well screen, with clean silica sand. A bentonite pellet seal (minimum 2-foot thickness) will then be installed; the remainder of the annulus of the boring will be backfilled with a cement-bentonite grout to ground surface. The depths of all backfill material will be constantly monitored during the well installation process by means of a weighted steel or plastic tape.

Protective steel casings equipped with locking caps will be installed around all wells. Flush mounted casings (see Figure 4-3) may be installed at locations where a protruding casing would be undesireable (near roadways). Keyed-alike locks will be supplied by the drilling subcontractor for all wells. Monitoring wells will be surveyed after installation to determine vertical and horizontal coordinates.

4.3.2.3 Well Development

Monitoring wells will be developed after installation to remove fines and sediments from around the well screens and to remove drill cuttings and residual drilling fluids from the area around the monitored interval of the boring. Wells will be developed

MONITORING WELL

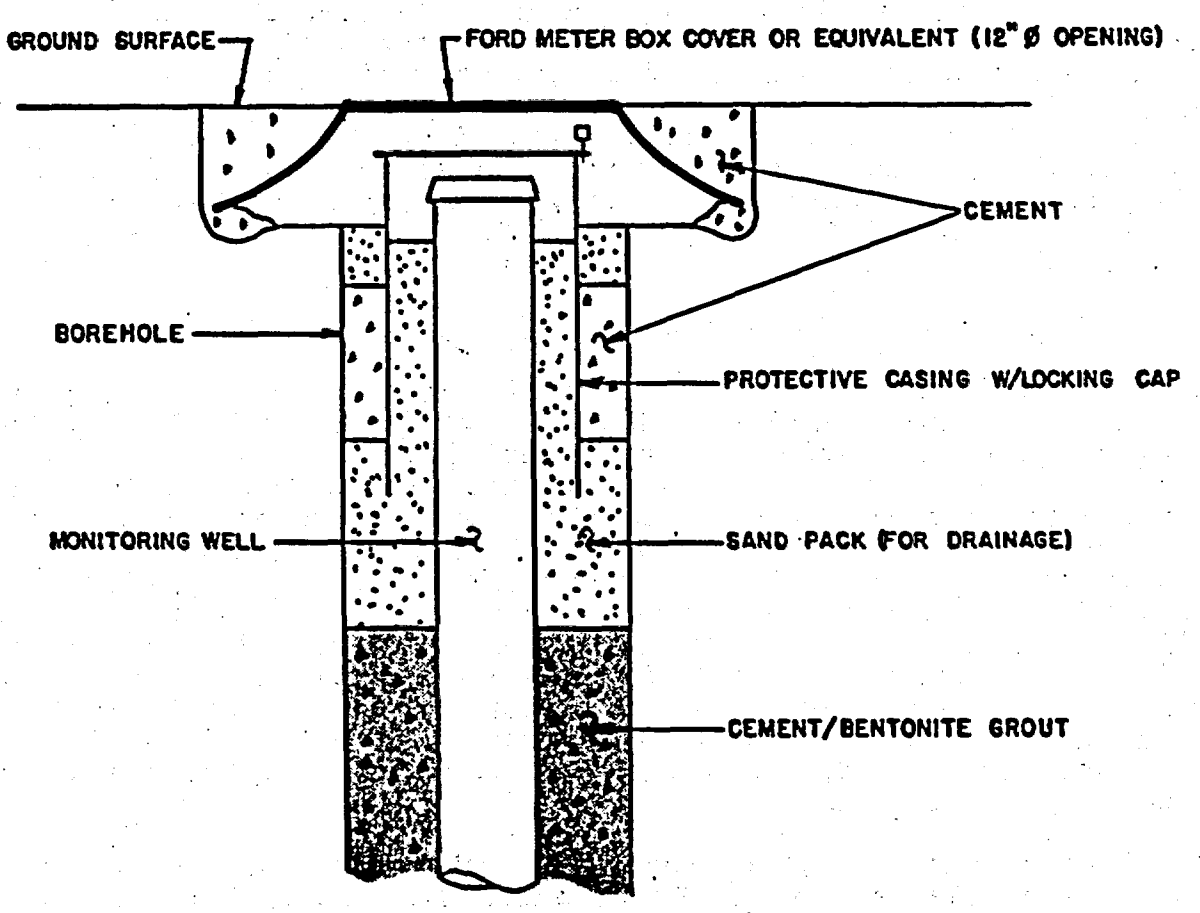


MONITORING WELL CONSTRUCTION
CROYDON TCE SITE, BUCKS COUNTY, PA

NOT TO SCALE

FIGURE 4-2

NUS CORPORATION



FLUSH MOUNTED
PROTECTIVE CASING INSTALLATION
CROYDON TCE SITE, BUCKS COUNTY, PA
NOT TO SCALE

FIGURE 4-3

NUS CORPORATION

by air lift, bailing and surging, or by pumping, as determined by the field geologist.

4.3.2.4 Aquifer Testing

Monitoring wells will be used for aquifer testing to determine the groundwater flow conditions in the alluvial aquifer investigated at the site. The data generated from these tests will be used to define the water-yielding characteristics of the formation, develop groundwater velocity values for the alluvial aquifer, and estimate the rate of groundwater movement across and away from the site. Slug tests or short-term pumping tests will be performed in the selected monitoring wells and evaluated using the most appropriate evaluation technique for each type of test and for each individual set of hydrogeologic conditions. (The wells and evaluation techniques wil be determined following the drilling program.) Pressure transducers and data loggers will be used for data collection, where appropriate, to obtain the most accurate field data possible. It is anticipated that each new monitoring well will be tested.

4.3.2.5 Water Level Monitoring

At least two comprehensive rounds of water levels will be taken in the 29 newly-installed REM III and selected Rohm & Haas monitoring wells during the hydrogeologic investigation. Staff gauge readings along Hog Run Creek will be recorded during each round of water level measurements. All measurements for each collection round shall be collected within a 24-hour period of consistent weather conditions to minimize atmospheric/ precipitation effects on groundwater conditions. Measurements will be taken with an M-scope (electrical water-level indicator), using the top of the well casing as the reference point for determining depths of water. These water levels will be used to determine groundwater flow directions and to identify any variations which may occur in flow directions throughout the study area over time.

Continuous water level recorders will be installed at 5 monitoring well locations (Locations 1,3,9,12 and 15), to obtain data regarding the potential influence of tides on groundwater within the study area. Single water level recorders will be installed on the shallow wells at three locations, and water level recorders will be installed on both wells at two locations. A minimum of one week of continuous data will be obtained from each of the wells.

4.3.2.6 Field Sampling Program

The sampling program for the hydrogeologic investigation will be conducted as follows:

1. Following the development of all 29 newly-installed monitoring wells, groundwater samples wil be collected and analyzed for benzene, vinyl chloride, TCE, and PCE via field GC analysis.

2. One complete round of groundwater samples will be collected from the 29 REM III monitoring wells and the 19 Rohm & Haas monitoring wells. This sampling will be implemented approximately 1 week following the conclusion of the drilling program.

FIELD GC ANALYSIS

Following the development of the REM III monitoring wells, samples will be obtained for GC confirmation of selected target compounds, benzene, vinyl chloride, TCE, and PCE. (See FOP, Appendix B, for description of proposed GC analysis methodology.) These contaminants were detected during previous investigations within the study area. Samples collected for field GC analysis will be transported to the onsite REM III Team mobile laboratory for analysis. Laboratory turnaround time shall be approximately 24 hours. Results of the GC analysis will be communicated by phone to the Site Manager. Upon receipt of the GC results, the Site Manager will consult with EPA personnel on whether additional monitoring wells are required to delineate the boundaries of the groundwater plume. However, because there is a possibility that the contaminated groundwater plume may extend beyond the boundary of the proposed monitoring well scheme (i.e., north of well location 13 or 14), a maximum of three additional monitoring wells will be installed, if dictated by the field GC analysis.

The presence or absence of indicator contaminants in the newly-installed monitoring wells will provide information on the quality of groundwater upgradient and downgradient from the potential source areas. The purpose of this information is to determine whether additional monitoring wells (over and above the 27 proposed wells) are required to characterize the extent of groundwater contamination in the southeastern portion of the study area. Because of the short laboratory turnaround time, decisions to construct additional monitoring wells can be made while the drilling subcontractor and REM III field personnel are at the site. For example, the presence of contamination at well location 13 (see Figure 4-1) may necessitate the installation of another monitoring well further upgradient (north) in order to characterize background groundwater conditions. EPA will be consulted prior to making this decision.

Sampling and GC analysis protocols, and Quality Assurance/Quality Control (QA/QC) requirements are outlined in the FOP.

MONITORING WELL SAMPLING

One round of groundwater samples will be collected from the newly-installed wells and 19 Rohm & Haas wells, and analyzed for volatile organics (via a modified EPA Method 624) and TCL inorganics. Selected monitoring wells, based on their location, will be sampled and analyzed for water quality parameters including; total organic carbon (TOC), biological oxygen demand (BOD), nitrates (NO_3), nitrites (NO_2), sulfates (SO_4), total dissolved solids (TDS), total suspended solids (TSS), chlorides (Cl), carbonates (CO_3), bicarbonates (HCO_3), and ammonia (NH_3-H). Temperature, specific conductance, and pH will be analyzed in the field for all samples. TCL inorganics and the above-mentioned water quality parameters will be analyzed by Contract Laboratory Program (CLP) laboratories via Routine Analytical Services (RAS) and Special Analytical Services (SAS), respectively. The volatiles will be analyzed in the onsite REM III mobile laboratory in order to limit the volatilization of contaminants from the samples. A modified EPA Method 624 will be employed. (See FOP, Appendix B, for description of proposed Modified EPA Method 624 methodology.) This method was discussed with CLP QA/QC personnel during the preparation of this Work Plan. Because the data generated by this method will be used for assessing health risks, no substitute method will be performed in the onsite laboratory unless otherwise directed by CLP QA/QC personnel.

In addition to the volatile organics analysis (via a modified EPA Method 624), approximately 20 percent of the groundwater samples will be forwarded to a CLP laboratory for analysis of Target Compound List (TCL) organics and water quality parameters. These samples will be collected from the following REM III/Rohm & Haas monitoring wells, which were chosen to represent various portions (i.e., east, west, central) of the study area:

- REM III Well Cluster Nos. 13, 3, and 5 (6 samples)
- BCM Well Cluster Nos. LF-15 and CR-24 (4 samples)

The monitoring well sampling will be initiated approximately one week after the conclusion of the drilling/well construction/development activities. Figure 4-1 depicts the proposed REM III monitoring well locations and the 19 Rohm & Haas well locations. Table 4-2 summarizes the field sampling and analysis program for the Phase I RI/FS.

Sampling and analysis protocols, and QA/QC requirements, are discussed in Section 4.4.

4.3.3 Residential Well Survey/Investigation

In order to assess the public health and environmental risks posed by groundwater within the study area (i.e., Objective Number 2), selected residential wells throughout the study area

will be sampled and analyzed for volatile organics (via a Modified EPA Method 624) and TCL inorganics. Selected residential wells, based on their location, will be sampled and analyzed for water quality parameters including: TOC, BOD, NO_3, NO_2, SO_4, TDS, TSS, Cl, CO_3, HCO_3, and NH_3-H. Temperature, pH, and specific conductance will be analyzed in the field for all samples. TCL inorganics and the above-mentioned water quality parameters will be analyzed by Contract Laboratory Program (CLP) laboratories via Routine Analytical Services (RAS) and Special Analytical Services (SAS), respectively. The volatiles will be analyzed in the onsite REM III mobile laboratory in order to limit the volatilization of contaminants from the samples. A modified EPA Method 624 will be employed. (See FOP, Appendix B, for description of proposed Modified EPA Method 624 methodology.) This method was discussed with CLP QA/QC personnel during the preparation of this Work Plan. Because the data generated by this method will be used for assessing health risks, no substitute mehod will be performed in the onsite laboratory unless otherwise directed by CLP QA/QC personnel.

In addition to the volatile organics analysis (via a modified EPA Method 624), approximately 20 percent of the groundwater samples will be forwarded to a CLP laboratory for Target Compound List (TCL) organics and water quality parameters. These samples will be collected from the following residential wells (see Figure 4-4) which were chosen to represent various portions (i.e., east, north, central) of the study area:

- 2925 West Avenue
- 2916 Lansdowne Avenue
- 1028 Rosa Avenue
- 1601 River Road
- 914 Belleview Avenue
- 922 Orchard Avenue
- 400 Main Avenue

In addition to providing information for assessing health risks, the sampling of residential wells will collect information that will be used to (1) determine background groundwater quality, (2) identify areas or "hot spots" that may exhibit similar groundwater contamination that was detected in the southeastern portion of the study area, and (3) help establish the Phase II RI/FS objectives and scope of work. Figure 4-4 depicts the candidate residential well locations. The number of samples/analysis for the residential well investigation are summarized on Table 4-2.

TABLE 4-2
SUMMARY OF FIELD SAMPLING AND ANALYSIS PROGRAM
CROYDON TCE SITE

Analysis	Number of Samples/Analyses				
	Groundwater (Monitoring Wells)*	Groundwater (Residential Wells)	Surface Water	Sediment	Soil
Volatile Organic (Modified Method 624)	48	40	NA	NA	NA
TCL organics**	10	7	22	22	8
TCL inorganics	48	40	22	22	8
TOC	10	7	NA	NA	8
BOD	10	7	NA	NA	NA
Nitrates	10	7	NA	NA	NA
Nitrites	10	7	NA	NA	NA
Sulfates	10	7	NA	NA	NA
Chlorides	10	7	NA	NA	NA
Carbonates	10	7	NA	NA	NA
Bicarbonates	10	7	NA	NA	NA
Ammonia	10	7	NA	NA	NA

TABLE 4-2
SUMMARY OF FIELD SAMPLING AND ANALYSIS PROGRAM
CROYDON TCE SITE
PAGE TWO

Analysis	Number of Samples/Analyses				
	Groundwater (Monitoring Wells)*	Groundwater (Residential Wells)	Surface Water	Sediment	Soil
TDS	10	7	NA	NA	NA
TSS	10	7	NA	NA	NA
pH (field)	48	40	NA	NA	NA
Specific conductance (field)	48	40	NA	NA	NA

Notes: (1) This table presents the total number of samples and analyses but does not inlcude QA/QC samples (blanks, duplicates, et.). A complete listing of samples and analyses, including QA/QC samples, is given in Table 4-4.
(2) pH, temperature, and specific conductance will be determined via in-situ testing.
(3) The Number of TCL organic analyses is an estimation and is based on approximately 20 percent of the total number of samples that will be anlyzed (via the Modified EPA Method 624) by the REM III mobile laboratory.

NA: Denotes "not analyzed for"

*: Consists of 29 REM III Team monitoring wells and 19 Rohm & Haas monitoring wells.
**: Consists of approximately 20 percent of the total number of samples that will be analyzed in the REM III Team mobile laboratory (Modified EPA Method 624).

The candidate residential wells were identified by conducting a residential well survey during the preparation of this work plan. Because the entire study area is not serviced by a public water supply, it was important to identify "sole-source" residential well owners since the extent of groundwater is unknown. A total of 482 questionnaires were prepared and forwarded to "potential" sole-source residential well users. Potential sole-source well users were identified by reviewing tax records of properties which bordered streets without public water lines. The streets were identified by reviewing a water distribution map of the area and by consulting various Bristol Township officials. Of the 482 questionnaires that were distributed, 120 responses were received. The responses can be categorized as follows:

- 40 owned residential wells
- 69 did not have/use a residential well (i.e., a public water supply)
- 11 vacant properties

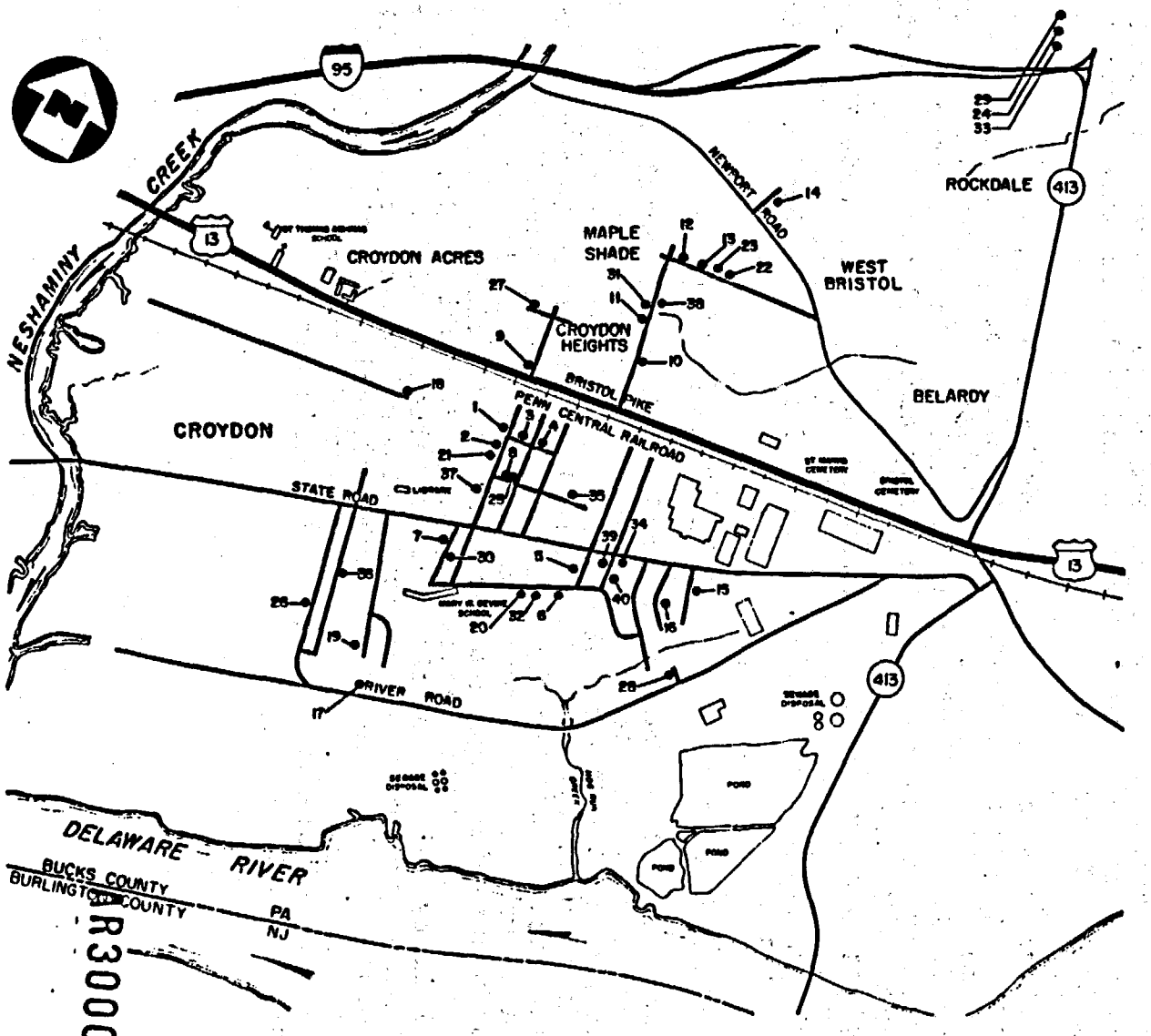
The 362 "non-responses" are being contacted by telephone to determine if they use or have a residential well.

The Phase I RI will provide additional details regarding the use of groundwater by the home owners. The residential wells to be sampled as part of this investigation are being used for either one or all of the following reasons:

- Consumption
- Bathing/Washing
- Cooking
- Gardening
- Laundry

4.3.4 Soil Investigation

A limited soil investigation will be conducted during the Phase I RI to collect data that can be used in the Risk Assessment. Because only four surface soil samples were collected during previous investigations, and the samples were analyzed for only TCE and inorganics, a limited amount of information is available to assess exposure routes (direct contact) that may be associated with the study areas soils. However, since there is no known source of contamination, a sampling program to select the appropriate numbers, locations, and depths of soil samples was difficult to scope.



Identification Number	Address
1.	209 Linton Avenue
2.	300 Linton Avenue
3.	2314 Brighton Avenue
4.	2401 Brighton Avenue
5.	817 Girard Avenue
6.	1901 Summit Avenue
7.	841 Keystone Street
8.	400 Grant Avenue
9.	Route 13 & Penn Street
10.	306 Franklin Avenue
11.	2050 High Street
12.	2310 Maple Avenue
13.	2311 Maple Avenue
14.	2916 Lansdowne Avenue
15.	914 Belleview
16.	922 Orchard Avenue
17.	1601 River Road
18.	1311 Sycamore Avenue
19.	1019 Emily Avenue
20.	1909 Summit Avenue
21.	401 Linton Avenue
22.	2323 Maple Avenue
23.	2319 Maple Avenue
24.	3017 West Avenue
25.	603 Grant Street
26.	1028 Rosa Avenue
27.	2208 Garfield Street
28.	400 Main Avenue
29.	2925 West Avenue
30.	812 Keystone Street
31.	2056 High Street
32.	1905 Summit Avenue
33.	2920 West Avenue
34.	211 Elm Avenue
35.	1612 Pennsylvania Avenue
36.	515 Excelsior Avenue
37.	413 Linton Avenue
38.	2055 High Street
39.	301 Elm Street
40.	401 Elm Street

0 1000 2000 3000 4000
SCALE IN FEET

FIGURE 4-4

PROPOSED RESIDENTIAL WELL SAMPLING LOCATIONS
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION

R300076

The Phase I Soil Investigation will consist of collecting four surface soil samples at Potential Source Area No. 13, which is located near the Mary W. Devine School and four samples from a residential property near River Road (see Figure 4-5). The school property was agreed upon during the RI/FS scoping meeting between the REM III Team and EPA Region III since likely exposure pathways could exist, due to the location near the school and the accessibility by children who play in the area. The residential property was selected following the Public Meeting of August 20, 1987, where a citizen claimed that soil (fill) from his property originated from Potential Source Area No. 11. The samples will be analyzed for TCL organics and inorganics via CLP RAS. As part of this Soil Investigation, a reconnaissance of Potential Source Area Numbers 1-4, and 6-10 (see Figure 2-3) will be conducted to observe if any visual signs of contamination are present. The observations will be documented in the field notebook and will be investigated as part of the Phase II RI.

Potential source areas identified by the current EPIC study, which is presently focusing on the area north of U.S. Route 13, will be included in the reconnaissance. Potential Source Areas 5, 12, and 11 will not be included in the reconnaissance since they are outside of the study area and have been studied by Rohm & Haas. It is anticipated that a more extensive soil sampling program will be conducted during the Phase II RI if sources of contamination are identified during the above-mentioned reconnaissance and/or the hydrogeological investigation.

4.3.5 Surface Water and Sediment Investigation

A total of 22 surface water and 22 sediment samples will be collected from the Croydon TCE study area and vicinity as shown in Figure 4-6. The samples will be analyzed for TCL organics and inorganics via CLP RAS. The information collected by this investigation will be used to determine the quality of local surface waters in order to estimate the impact from the groundwater discharge and estimate health risks associated with the use of these waters (i.e., Objective No. 3). The possibility of conducting biota studies will be evaluated following receipt of analytical data and consultation with EPA. The biota sampling would be conducted during the Phase II RI, if necessary. The number of samples/analyses are summarized on Table 4-2. Table 4-3 provides the basis, or rationale, for each sampling location.

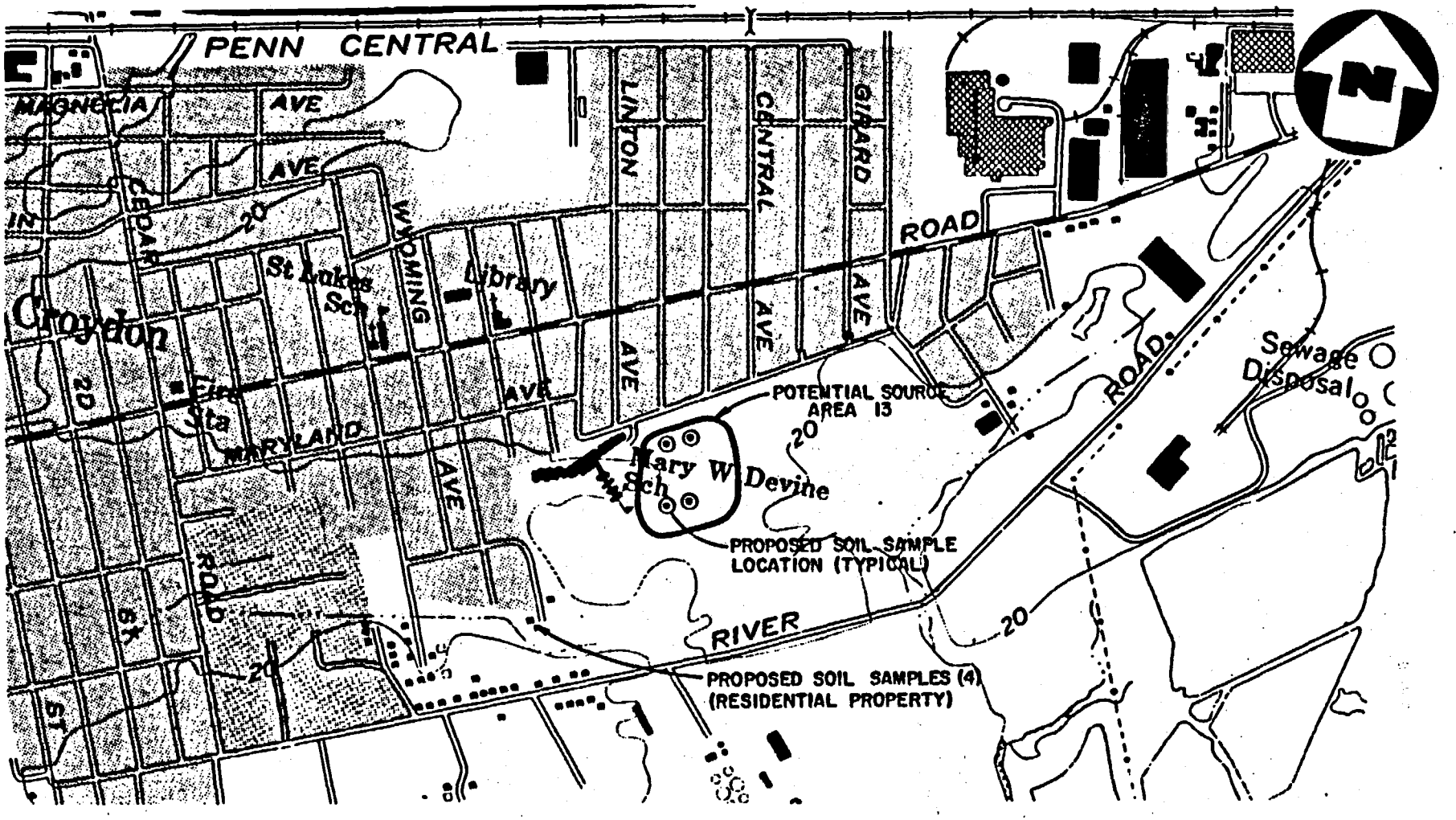
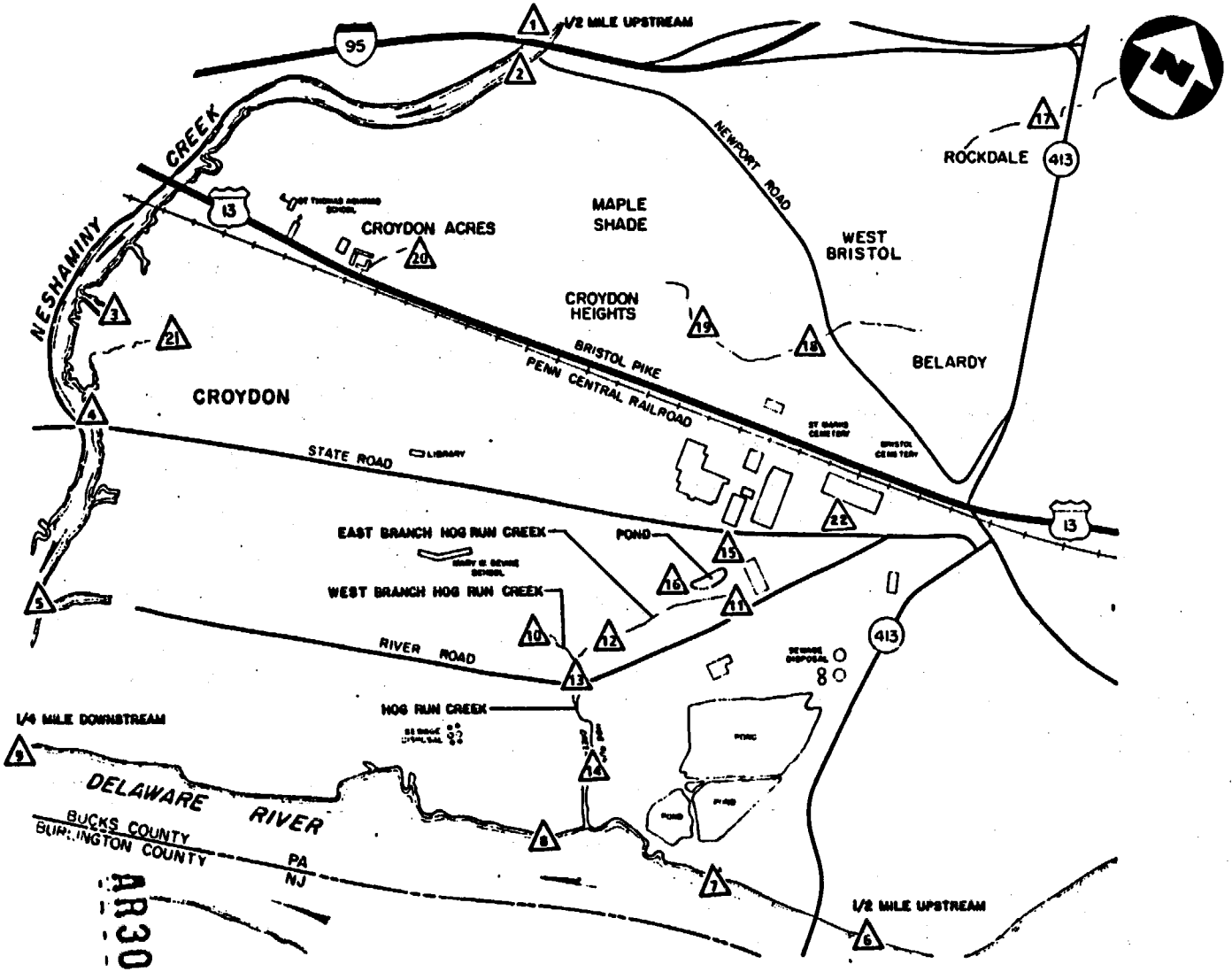


FIGURE 4-5

PROPOSED SURFACE SOIL SAMPLING LOCATIONS
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION



LEGEND

10 Denotes proposed surface water and sediment sampling location, No. 10

0 1000 2000 3000 4000
SCALE IN FEET

FIGURE 4-6

PROPOSED SURFACE WATER & SEDIMENT SAMPLING LOCATIONS
CROYDON TCE SITE, BUCKS COUNTY, PA

NUS CORPORATION

TABLE 4-3

SURFACE WATER/SEDIMENT SAMPLING LOCATIONS AND RATIONALE
CROYDON TCE SITE

Station No.*	Description	Rationale
1	Neshaminy Creek - Upstream	Determine background surface water/sediment quality.
2	Neshaminy Creek - South of Interstate 95	Assess impact from study area.
3	Neshaminy Creek - Cover area near Main Avenue	Assess impact from study area. Potential swimming area.
4	Neshaminy Creek - State Road bridge	Assess impact from study area and an upgradient intermittent stream.
5	Neshaminy Creek - Near discharge to Delaware River	Assess impact from study area and upgradient intermittent stream.
6	Delaware River - Upstream	Determine background surface water/sediment quality.
7	Delaware River - Adjacent to Rohm and Haas landfill area	Determine surface water/ sediment quality prior to potential influence of Hog Run Creek.
8	Delaware River - downstream from confluence with Hog Run Creek	Assess impact from Hog Run Creek
9	Delaware River - downstream from confluence with Neshaminy Creek	Assess impact from Neshaminy Creek.
10	West Branch Hog Run Creek	Assess impact from contaminated groundwater.
11	East Branch Hog Run Creek (upstream)	Assess impact from contaminated groundwater. Compare with previous results.
12	East Branch Hog Run Creek (downstream)	Same as No. 11.
13	Hog Run Creek (upstream)	Same as No. 11.
14	Hog Run Creek (downstream)	Assess impact from adjacent landfill.

TABLE 4-3
SURFACE WATER/SEDIMENT SAMPLING LOCATIONS AND RATIONALE
CROYDON TCE SITE
PAGE TWO

Station No.*	Description	Rationale
15	Pond near Potential Source Area No. 8 (eastern side of Pond)	Assess impact from Potential Source No. 8.
16	Pond near Potesntial Source Area No. 8 (western side of pond)	Same as No. 15.
17	Intermittent Stream near the Community of Rockdale	Assess impact, if any, of groundwater in this portion of the study area.
18	Intermittent stream near Potential Source Area No. 1 (eastern portion)	Assess impact, if any, of groundwater. Determine influence of Potential Source Area No. 1.
19	Intermittent stream near Potential Source Area No. 1 (western portion)	Same as No. 18.
20	Intermittent stream near St. Thomas School	Determine impact, if any, of groundwater in this portion of the study area.
21	Intermittent stream near Main Avenue	Determine impact, if any, of groundwater in this portion of the study area.
22	Intermittent stream near Coyne Chemical	Determine characteristics of surface water/sediments, which were noted to be discolored during an EPA reconnaissance.

*Station numbers can be cross-referenced with Figure 4-6.

4.4 TASK 4 - SAMPLE ANALYSIS AND VALIDATION

4.4.1 Sample Analysis

Table 4-4 identifies the method of analysis for each parameter, by media, for the Phase I RI field activities. The number of samples, including QA/QC samples, are also provided on Table 4-4. Analytical procedures to be employed by the REM III Team mobile laboratory are given in Appendix B of the FOP. A modified EPA Method 624 will be employed for volatile organic analysis of groundwater and for field GC analysis of target compounds. CLP laboratories will also be employed, as noted on Table 4-4. Analytical methods to be used for SAS requests are included (analytical methods for RAS are standard CLP methods). Field analysis of pH, temperature, and specific conductance is described in REM III Program Guideline 7.10 (on-site water quality testing) and will be performed in the field.

4.4.2 Quality Control and Data Validation

Validation is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The process includes the following activities:

- Auditing measurement system calibration and calibration verification;
- Auditing quality control activities;
- Screening data sets for outliers;
- Reviewing data for technical credibility versus the sample site setting;
- Auditing field sample data records and chain-of-custody;
- Checking intermediate calculations; and
- Certifying the previous process.

The review and validation of CLP and REM III laboratory data will be conducted by REM III Team chemists using the following EPA documents:

TABLE 4-4

SUMMARY OF SAMPLE ANALYSES AND ANALYTICAL METHODS
CROYDON TCE SITE

Media	Number of Samples	Number of Field Duplicates	Field Blanks	Trip Blanks	Analysis	Source of Analysis	Analytical Method	DQO Level of Analysis
Groundwater	29(1)	2	2	2	TCE, PCE, benzene, vinyl chloride	REM III Mobile Lab		II
	88(2)	5	5	10	Volatile Organics	REM III Mobile Lab	Modified 624	V
	17(3)	1	1	2 (VOA only)	TCL Organics	CLP	RAS	IV
	88	5	5	-	TCL Inorganics	CLP	RAS	IV
	17	1	1	-	TOC	CLP	SAS/415.1*	III
	17	1	1	-	BOD	CLP	SAS/507**	III
	17	1	1	-	TDS	CLP	SAS/160.1*	III
	17	1	1	-	TSS	CLP	SAS/160.2*	III
	17	1	1	-	Nitrates	CLP	SAS/352.1*	III
	17	1	1	-	Nitrites	CLP	SAS/354.1*	III
	17	1	1	-	Carbonates	CLP	SAS/403**	III
	17	1	1	-	Bicarbonates	CLP	SAS/403**	III
	17	1	1	-	Sulfates	CLP	SAS/375.4*	III
	17	1	1	-	Chlorides	CLP	SAS/407B**	III

TABLE 4-4
SUMMARY OF SAMPLE ANALYSES AND ANALYTICAL METHODS
CROYDON TCE SITE
PAGE TWO

Media	Number of Samples	Number of Field Duplicates	Field Blanks	Trip Blanks	Analysis	Source of Analysis	Analytical Method	DQO Level of Analysis
Groundwater	17	1	1	-	Ammonia	CLP	SAS/350.2*	III
	17	1	1	-	pH	Field	See FT-7.10	I
	17	1	1	-	Temperature	Field	See FT-7.10	I
	17	1	1	-	Specific Conductance	Field	See FT-7.10	I
Soil	8	1	1 (water)	1 (VOA only)	TCL Organics	CLP	RAS	IV
	8	1	1 (water)	-	TCL Inorganics	CLP	RAS	IV
Surface Water	22	2	2	2 (VOA only)	TCL Organics	CLP	RAS	IV
	22	2	2	-	TCL Inorganics	CLP	RAS	IV
Sediment	22	2	2 (water)	2 (VOA only)	TCL Organics	CLP	RAS	IV
	22	2	2 (water)	-	TCL Inorganics	CLP	RAS	IV

* Source is Methods for Chemical Analysis of Water and Wastes, USEPA, March 1983.
** Source is Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 16th Edition
(1) 29 samples represent the REM III Team monitoring wells.
(2) 88 samples represent the 29 REM III Team wells, 19 Rohm and Haas wells, and 40 residential wells.
(3) 17 samples represent approximately 20 percent of the total number of samples (88) that will be analyzed in the onsite REM III Team mobile laboratory via the Modified EPA Method 624 procedure.

- USEPA, 1986. Laboratory Data Validation, Functional Guidelines for Evaluating Organic Analyses. EPA Technical Directive Document No. HQ8410-01. Hazardous Site Control Division. USEPA - OSWER, Washington, D.C. April 1985.

- USEPA, 1985. Laboratory Data Validation, Functional Guidelines for Evaluating Pesticides/PCB's Analyses. EPA Technical Directive Document No. HQ8410-01 Hazardous Site Control Division. 1985 USEPA - OSWER, Washington, D.C. May 1985.

- USEPA, Laboratory Data Validation, Functional Guidelines for Evaluating Inorganic Analyses. EPA Office of Emergency and Remedial Response. USEPA - OSWER, Washington, D.C.

Several factors that will be considered are sample holding times, instrument calibration, blank results, surrogate recoveries, matrix spike/matrix spike duplicates, chain-of-custody, and any other control procedures that are applicable.

4.5 TASK 5 - DATA EVALUATION

The purpose of this task is to organize the validated data collected from the field and laboratories into a working format for analysis, and then perform the necessary evaluations to meet the project objectives. Task 5, therefore, has two distinct components; data reduction and data evaluation. Following are brief descriptions of these components.

4.5.1 Data Reduction

Data obtained from the various field investigations will be condensed and organized to facilitate evaluation and presentation in this subtask. Reduction of hydrogeologic data will result in the production of various tables, figures, and drawings describing and summarizing the pertinent site features. These might include:

- Figures displaying boring and monitoring well locations and elevations.
- Various hydrogeologic cross-sections.
- Flow nets and groundwater contours.
- Well log descriptions.
- Aquifer test data.

Data reduction will be facilitated by computerization. The computerized sampling and analytical data base will be amenable to manipulation and creation of different sorting profiles. Sorting profiles will assist in evaluating the occurrence and distribution of contaminants within the different media. Appropriate tables, maps, and figures will be produced to

summarize the occurrence and distribution of contaminants at the site and adjacent environs.

4.5.2 Data Evaluation

Once the data is reduced to a usable format, it will be reviewed and evaluated in order to determine if the Phase I RI/FS project objectives have been met. Because the Croydon TCE Site is being studied in two phases, the evaluation of data will also lay the frame work for establishing the Phase II objectives and scope of work. Additionally, data needed to meet the Phase I objectives, if any, will be identified so that it may be obtained during the Phase II RI.

4.6 RISK ASSESSMENT

4.6.1 Baseline Public Health/Environmental Assessment

The public health/environmental assessment will address the potential human health and environmental effects associated with the Croydon TCE Site under the no-action alternative. The no-action alternative assumes that no remedial (corrective) actions will take place at the site. Evaluation of the no-action alternative is required under Section 300.68(f)(v) of the National Contingency Plan (NCP). By conducting such an assessment, the Environmental Protection Agency (EPA) will be able to determine if remedial actions are indicated for any area of the site. In addition, the baseline assessment will also provide a basis for determining the reduction in risk resulting from remediation. The baseline assessment will be based on the RI environmental monitoring data and other information developed during the RI. The main steps in this assessment will be performed in accordance with the latest EPA policy and guidance on risk assessment in general and for Superfund sites in particular (EPA, 1986c).

The first step in the public health/environmental assessment will be to review the results of the environmental sampling and other information developed during the RI to identify chemicals of potential concern for detailed study during the risk assessment. A key element in this screening process is a comparison of site concentrations to background levels of chemicals in appropriate media; naturally occurring chemicals present at background concentrations will not be considered to be site-related and will not be evaluated in the assessment. In addition, chemicals present in blanks at similar concentrations (i.e., laboratory and field contaminants) will not be selected for the detailed analysis. Depending on the number of chemicals detected at the site, selection of a subset of chemicals referred to as the chemicals of concern or indicator chemicals may not be necessary. If the selection is needed, relative concentration, mobility, persistence, and toxicity of the contaminants in the environmental samples taken at the site will be considered.

AR300586

The objective of the exposure assessment is to identify actual or potential routes of exposure and characterize the likely magnitude of exposure to human or environmental receptors. Potential human exposure pathways that may be important under current or future land-use conditions include ingestion of groundwater, inhalation of volatiles released from groundwater, exposure to environmental receptors from the surface water bodies at the site, as well as any other potentially complete pathways. For each exposure scenario, concentrations in relevant environmental media (air, surface water, groundwater, and soil) at the potential receptors' locations will be identified. Where concentrations have not been measured at the exposure point, estimates of current concentrations may, in certain instances, be made using models. The choice of models will be based on the sampling results. They may be simple partitioning models to determine release from soil or water to another medium (e.g., air) or more complex transport models. It is not possible to identify the specific models that will be selected here since it is not known what the data will reveal about the distribution of chemicals from the site. Should the modeling become necessary, the appropriate models will be selected from the available literature (i.e., EPA publications and reviewed journals). As part of this scope of work, models to predict the release of volatiles from groundwater used in the home will be developed as discussed below. All models and assumptions will be documented in the report and supplemented with appendices as appropriate.

Chemical intakes for each human exposure scenario will be estimated based on frequency and duration of exposure and rate of media intake (e.g., amount of water ingested per day). Human exposure is expressed in terms of intake which is the amount of a substance taken into the body per unit body weight per unit time. A chronic daily intake (CDI) is averaged over a lifetime for carcinogens (EPA, 1986a) and over the exposure period for noncarcinogens (EPA, 1986b). The CDI is calculated separately for each exposure pathway, since different populations-at-risk may be affected by the individual pathways. The assumptions used in these estimates will be stated clearly and thoroughly documented to the extent possible. The assumptions will be selected to represent an "average exposure case" and a "plausible maximum case." The exposure of nonhuman receptors will be estimated based on the sampling results or, if necessary, on the use of appropriate models that have appeared in the open literature.

Included in the risk assessment task will be the development of models which may quantify exposure by a variety of indoor air pathways to be quantified. The pathways that will be considered are inhalation while showering, washing clothes, flushing the toilet, washing dishes, and any other indoor activities which require the use of water and could result in the release of volatile organics. The number of models that will be developed

will depend on the amount of information that can be used to quantify releases. All assumptions will be documented and presented in the report.

The quantitative risk assessment will combine the results of the exposure assessment with the critical toxicity values in the appropriate media for each chemical of concern. For humans, toxicity data will be presented as:

1. For potential carcinogens, the carcinogenic potency factor;

2. For noncarcinogens, the estimated risk reference dose (RFD);

3. For chemicals for which no critical toxicity values are available, a semi-quantitative characterization based on any pertinent information that is available (e.g., subchronic toxicity studies or structural analogies)

For environmental receptors, environmental concentrations that have been associated with adverse effects in field or laboratory studies will be identified when available.

In addition to critical toxicity values, any applicable or relevant and appropriate requirements (ARARs) that have been established for the potential chemical(s) of concern will be identified. Currently, EPA considers maximum contaminant levels (MCLs) developed under the Safe Drinking Water Act, Federal Ambient Water Quality Criteria (AWQC), National Ambient Air Quality Standards (NAAQS), and state environmental standards to be potential ARARs for use in risk assessment at Superfund sites.

Risk assessments will be conducted separately for each exposure pathway and for each source when appropriate. Results will be presented separately for the "average exposure case" and the "plausible maximum case" exposure assumptions. The risk assessment for each exposure pathway will include a discussion of the uncertainties in the estimates.

4.7 TASK 7 - TREATABILITY STUDY/PILOT TESTING

At the present time, no treatability studies or pilot testing are anticipated. This task has been retained in the task numbering sequence, however, to allow for the possibility that the need for a treatability study and/or pilot test may arise at a later time.

The need for treatability studies and/or pilot testing will be re-evaluated following completion of data validation/evaluation and the initial screening of remedial technologies. Studies and testing of that kind, if found to be appropriate and necessary, will become the subject of a Technical Memorandum explaining the

rationale for the work and objectives and the scope of activities. The work will not commence without EPA Region III concurrence and approval. It is anticipated that treatability studies may be appropriate during the Phase II RI/FS and upon identification of the waste source(s).

4.8 TASK 8 - REMEDIAL INVESTIGATION REPORT

This task encompasses the preparation of the draft and final editions of the Phase I Remedial Investigation Report. The Phase I RI Report will include the following discussions:

- Site features investigation
- Hydrogeologic investigation
- Residential well survey and investigation
- Surface water and sediment investigation
- Soil investigation
- Public health and environmental concerns

A meeting will be held at EPA Region III following the development of the Draft Phase I RI Report. This meeting will summarize the findings of the Phase I RI.

5

5.0 TASK PLAN FOR FEASIBILITY STUDY

A Feasibility Study (FS) (Phase I) will be conducted following the Phase I RI in order to evaluate alternatives to assess the groundwater contamination in the southeastern portion of the study area and to assess the problem of residences depending on groundwater as a source of potable water. A Record of Decision (ROD) will be initiated by EPA following the Phase I RI/FS. The Phase II FS will evaluate remedial alternatives to mitigate source areas that are identified during the Phase I RI (if the source of contamination is not identified during the Phase I RI, EPA will decide whether a Phase II FS is needed). A second ROD wil be initiated by EPA following the Phase II RI/FS. The Phase I FS will consist of four tasks:

- Task 9 - Remedial Alternatives Screening;
- Task 10 - Remedial Alternatives Evaluation;
- Task 11 - Feasibility Study Report; and
- Task 12 - Post RI/FS Support.

The overall objective of the Croydon TCE Site FS is to screen and evaluate remedial alternatives based on the results of the Phase I RI and, in particular, the risk assessment. This information will be sufficient to allow EPA to select a remedial action that is:

- Protective of human health and the environment;
- Cost effective;
- In accordance with CERCLA as amended by SARA; and
- In accordance with the NCP (Section 300.68).

5.1 TASK 9 - REMEDIAL ALTERNATIVES SCREENING

Remedial alternatives will be screened as the first step in the FS process. The objective of this task is to refine the range of response actions developed during the scoping process (Task 1). This task will employ data collected in the Field Investigation (Task 3), and Risk Assessment (Task 6). The subtasks comprising Task 9 will accomplish the following objectives:

- Development of remedial response objectives and General Response Actions;
- Identification of applicable technologies and assembly of alternatives; and
- Screening of remedial technologies/alternatives.

5.1.1 Development of Remedial Response Objectives and Response Actions

Based on the data collected in the Phase I RI, the remedial response objectives will be developed more fully. Specific response objectives will be developed using a risk-based methodology to define cleanup levels that would mitigate risks to public health and the environment to acceptable levels. Potential contaminant migration pathways and exposure pathways, identified in the Risk Assessment, will be examined further as a basis for estimating acceptable onsite residual contamination levels. Acceptable exposure levels for potential receptors will be identified and onsite cleanup levels will then be estimated by extrapolating from receptor points back to source areas (if defined) along critical migration pathways. Development of response objectives will also include refinement of ARARs specific to the Croydon TCE Site.

5.1.2 Identification of Applicable Technologies and Assembly of Alternatives

Based on the remedial response objectives, a list of applicable technologies will be identified. This list will contain technologies previously identified in Section 3.4. After potential remedial technologies have been chosen, operable units may be defined for each site condition requiring remediation. Each operable unit should meet at least one response objective. For the Croydon TCE Site, groundwater is most likely the only operable unit that will be considered during the Phase I RI/FS.

After operable units have been defined, remedial alternatives will be identified. Each remedial alternative will be an overall site remedy incorporating more than one operable unit. The no-action alternative will be considered as baseline against which the other alternatives can be evaluated.

CERCLA, as amended by SARA, states that, to the maximum extent practicable, remedial actions that utilize permanent solutions and alternative treatment technologies or resource recovery technologies must be selected. Therefore, remedial actions that use these technologies will specifically be considered. To the extent possible, treatment options will emphasize alternatives that eliminate the need for long-term management at the site and alternatives involving treatment that would reduce toxicity, mobility, and volume as a principal goal.

5.1.3 Screening of Remedial Technologies and Alternatives

The lists of technologies and alternatives discussed previously will be screened. The objective of this effort is to eliminate from further consideration any technologies and alternatives that have undesirable results regarding implementability, effectiveness, and cost. The list of alternatives being considered will be narrowed by eliminating:

AR301092

- Technologies/alternatives which are not implementable or technically inapplicable.

- Technologies/alternatives which are not effective because they have adverse environmental impacts, do not provide adequate protection of public health, or do not attain ARARs; and

- Technologies/alternatives which are more costly than other alternatives/technologies but do not provide greater environmental or public health benefits, reliability, or a more permanent solution. Costs will not be used to discriminate between treatment technologies and nontreatment technologies.

Reasons for elimination of any alternative at this stage will be documented in the FS report.

5.2 TASK 10 - REMEDIAL ALTERNATIVES EVALUATION

Remedial alternatives which pass the initial screening process (Task 9) will be further evaluated and compared as required in the NCP and in CERCLA as amended by SARA. Effectiveness, implementability, and cost will be considered. The effectiveness evaluation will include consideration of public health risks, environmental impacts, and attainment of ARARs. As part of this evaluation process, SARA Subsection 121(b)(1) requires that waste, site, and inherent limitations, as well as the ability of each alternative to meet ARARs, be taken into account. Factors that should receive special consideration include:

- The long-term uncertainties of land disposal;

- The goals and requirements of the Solid Waste Disposal Act;

- The persistence, toxicity, mobility, and bioaccumulation of contaminants at the site;

- The short and long-term potential for adverse human health effects;

- The long-term operation and maintenance costs;

- The potential for future remedial action costs if the remedy fails; and

- The potential threat to human health and the environment from the excavation, transportation, and redisposal or containment of hazardous substances, pollutants, or contaminants.

Both short and long-term effects for each of these factors will be assessed. To the extent possible, remedial alternatives that use permanent solutions and alternative treatment technologies will be considered.

5.3 TASK 11 - FEASIBILITY STUDY REPORT

Task 11 will consist of the following subtasks:

- Summarize each alternative in terms of effectiveness, implementability, and cost;
- Compare the remedial alternatives; and
- Prepare the Phase I FS report.

The Phase I FS report will include an executive summary, an introduction, a description of the screening and evaluation process, a summary of the detailed technical and cost evaluations, and a comparative evaluation of the remedial alternatives. This summary will be presented as table matrices. Backup information and calculations will be included as appendices.

Following the development of the Draft Phase I FS, a meeting will be conducted at EPA Region III to discuss the alternatives considered for the Phase I RI/FS.

5.4 TASK 12 - POST RI/FS SUPPORT

The REM III Team will provide support to EPA following the completion of the Croydon TCE Site Phase I RI/FS. This support will include community relations, preparation of the Record of Decision and Responsiveness Summary, and assistance to the U.S. Army Corps of Engineers or other parties involved in the remedial design/remedial action. As mentioned previously (see Task 1), the REM III Team may implement a Phase II RI/FS following this Phase I study. The Phase II RI/FS will consist of these same tasks (1-12) as identified in this Phase I RI/FS Work Plan. The Phase II RI/FS Work Plan will outline the scope of work and resources to conduct the Phase II RI and FS activities. The Phase II RI/FS Work Plan will be prepared during the preparation of the Phase I RI Report.

6

6.0 PROJECT MANAGEMENT APPROACH

6.1 ORGANIZATION AND APPROACH

The proposed project organization for the Croydon TCE RI/FS is shown in Figure 6-1. The Regional Manager (RM), Mr. Richard C. Evans, is responsible for the quality of all REM III work performed in Region III. Mr. Raymond P. Wattras will serve as the project Site Manager (SM). The SM has primary responsibility for implementing and executing the RI/FS. Supporting the SM are the Field Operations Leader (FOL), FS Leader, the RI Leader and other technical support staff. The FOL is responsible for the onsite management of activities for the duration of the site investigation. The RI leader is responsible for the implementation of the RI and preparation of the RI report. The FS Leader is responsible for the implementation and preparation of the FS report.

The RI/FS tasks included in this Work Plan, in addition to the schedule and budget, comprise the baseline plans which form an integrated management information system against which work assignment progress can be measured. The baseline plans are a precise description of how the work assignment will be executed in terms of scope, schedule, and budget. The project schedule and detailed cost estimate are presented in Sections 6.3 and 6.4, respectively.

6.2 QUALITY ASSURANCE AND DATA MANAGEMENT

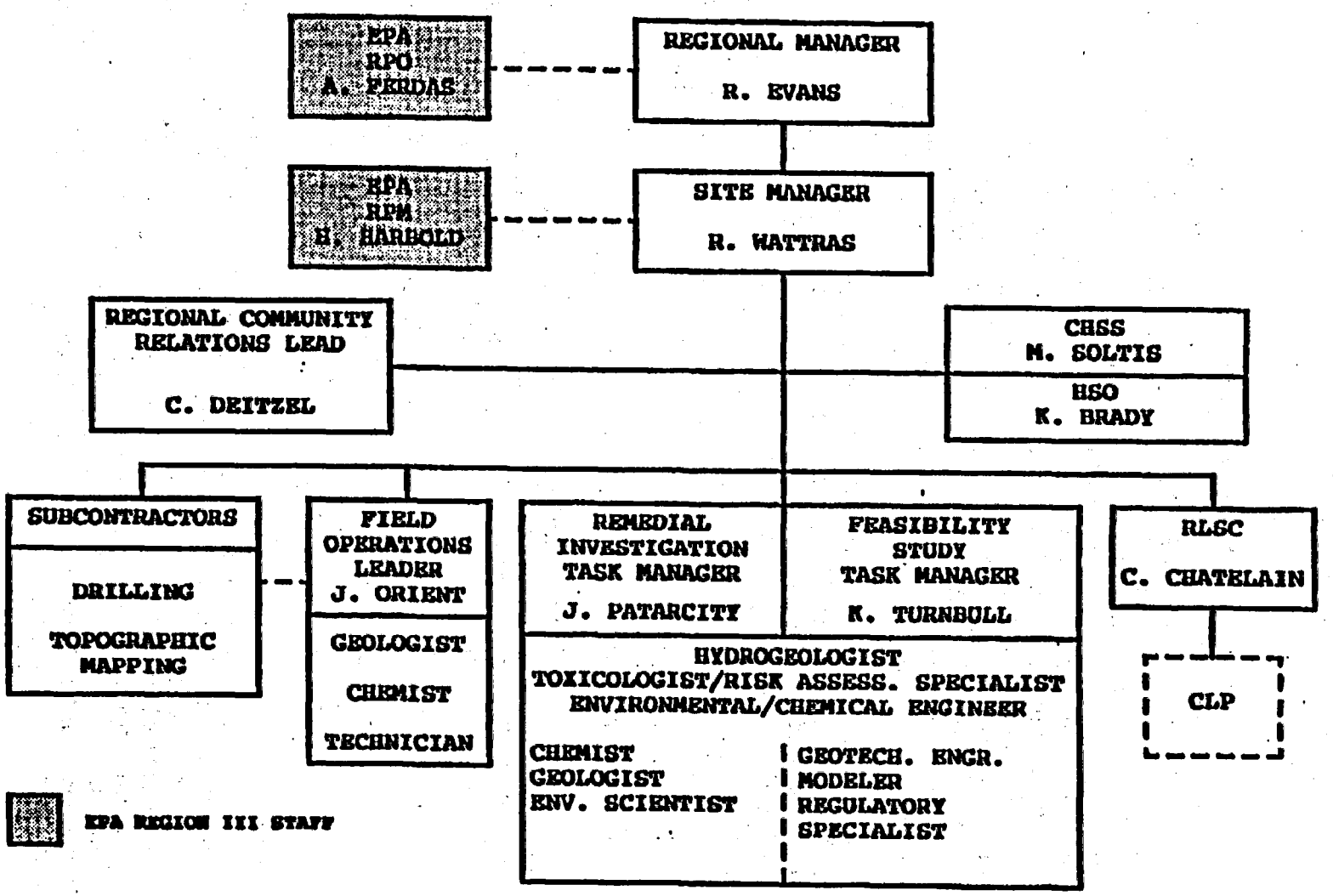
The site-specific quality assurance requirements will be in accordance with the Quality Assurance Program Plan (QAPP) for the REM III program, as approved by EPA. The REM III QAPP provides general guidance on the following subjects:

- Project organization and responsibility; and
- QA objectives for measurement of data in terms of precision, accuracy, representativeness, completeness, and comparability.

Data management aspects of the program pertain to controlling and filing documents. Ebasco has developed a program filing system (Administrative Guideline Number PA-5) that conforms to the requirements of EPA and the REM III Program to ensure that the integrity of the documents is safeguarded. This guideline will be implemented to control and file all documents associated with the Croydon TCE Site RI/FS. The system includes document receipt control procedures, a file review and inspection system, and security measures to be followed.

FIGURE 6-1

PROJECT ORGANIZATION
CROYDON TCE SITE



6.3 PROJECT SCHEDULE

Figure 6-2 depicts the schedule of tasks and activities for the Croydon TCE Site Phase I RI/FS. The schedule for the field investigation assumes that no site restrictions will be encountered and is dependent upon EPA approval of this Work Plan and the FOP by September 1, 1987.

6.4 COST ESTIMATES

The detailed cost estimate for the Croydon TCE Site RI/FS is presented under separate cover in the Optional Form 60 (OF-60). Costs for CLP analysis are not included in the REM III Team total cost. Costs for potential additional investigations, such as treatability study/pilot testing, are not included in the estimates for this Work Plan.

FIGURE 6-2
PROJECT SCHEDULE
CROYDON TCE SITE

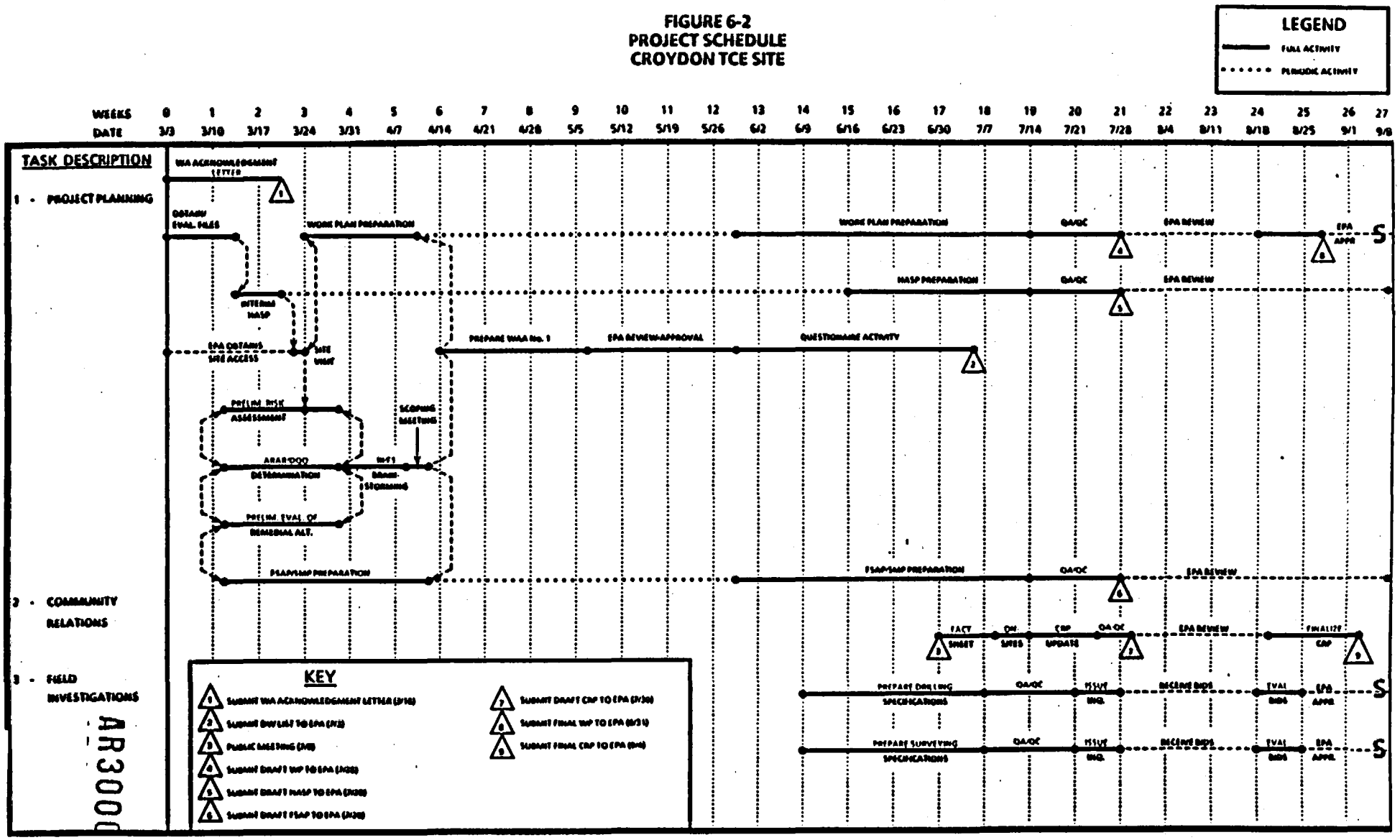


FIGURE 6-2
PROJECT SCHEDULE
CROYDON TCE SITE
PAGE TWO

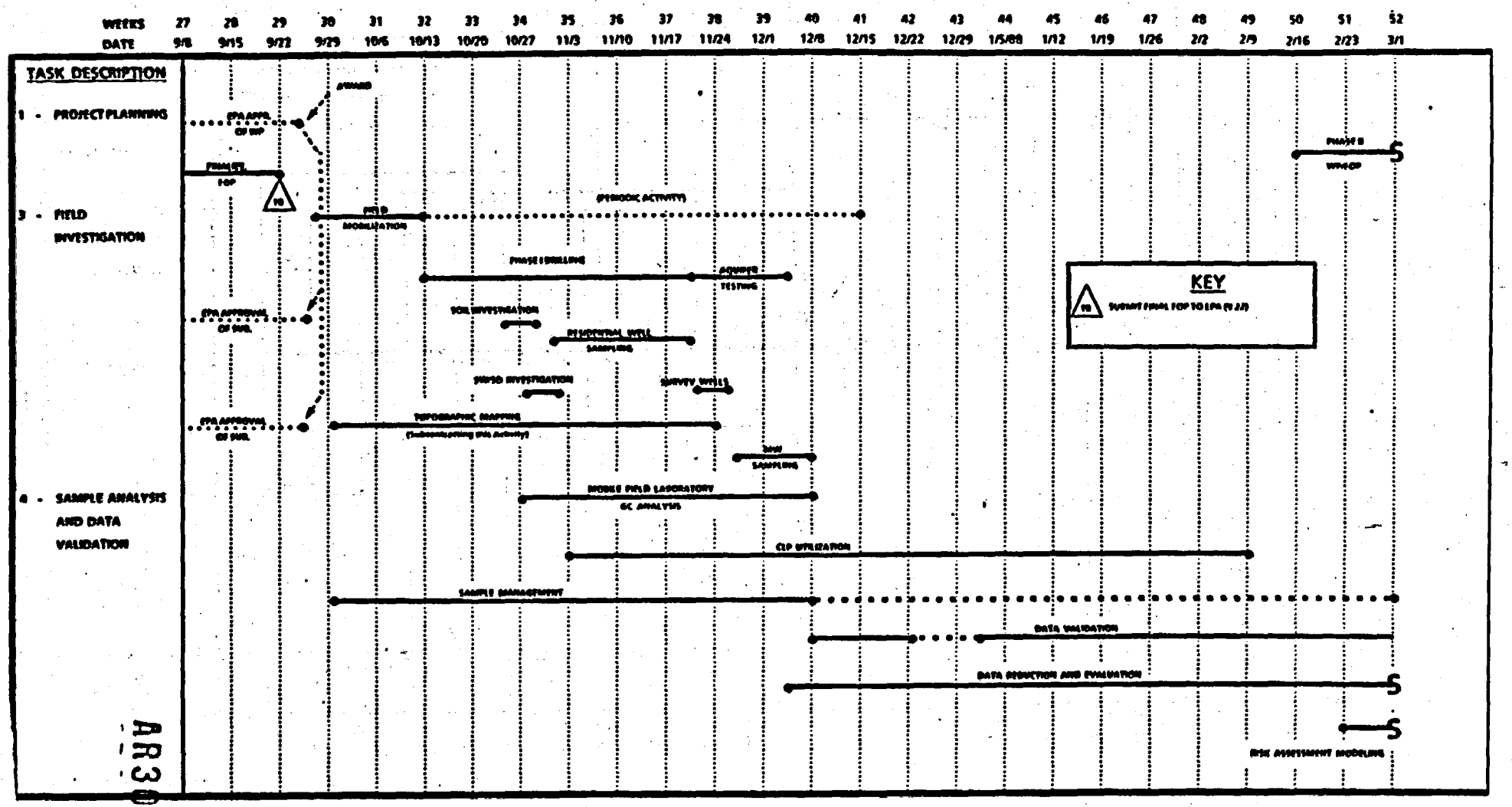


FIGURE 6-2
PROJECT SCHEDULE
CROYDON TCE SITE
PAGE THREE

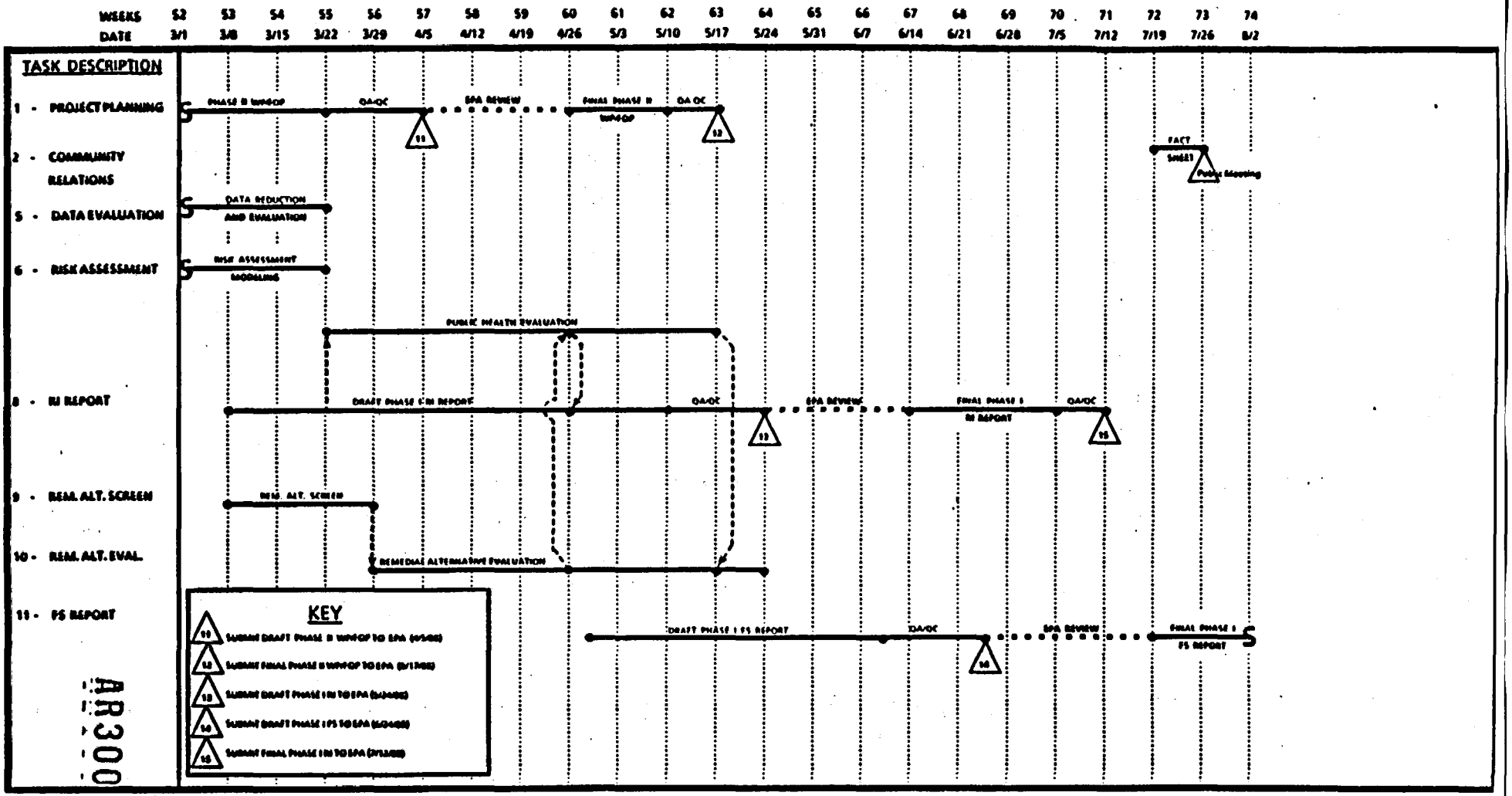
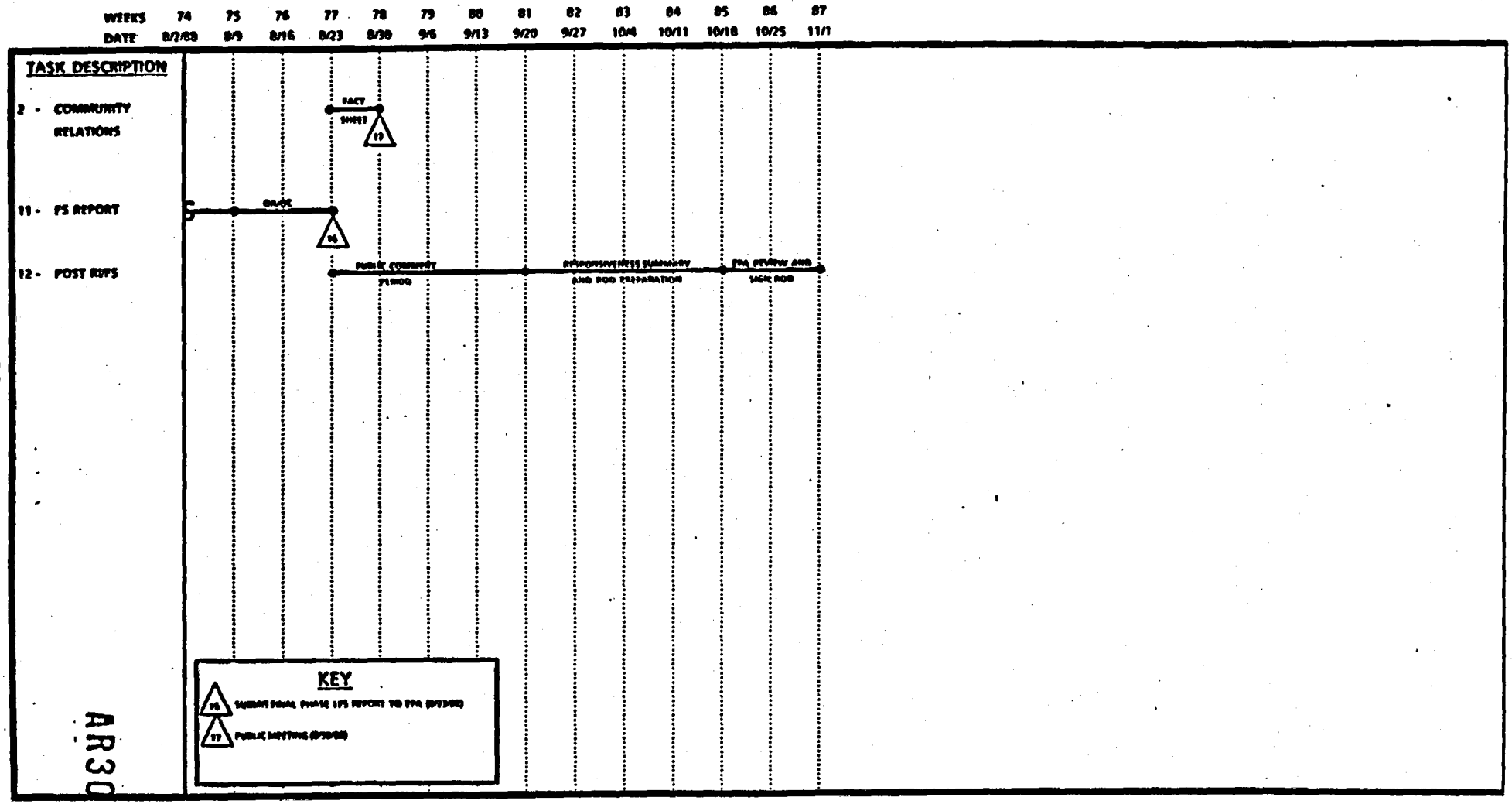


FIGURE 6-2
PROJECT SCHEDULE
CROYDON TCE SITE
PAGE FOUR



REFERENCES

AR300103

REFERENCES

BCM Eastern Inc. (BCM). 1984a. Report on Landfill Investigation. April 1984.

BCM Eastern Inc. (BCM). 1984b. Analysis of Residential Wells. Letter to Mr. Robert Lewis, Bristol Township Board of Supervisors. June 11, 1984.

BCM. 1985. Final Report on Landfill Resampling. Prepared for Rohm and Haas Company, Bristol, Pennsylvania. BCM Project No. 00-4016-06. February 1985.

BCM. 1986a. TCE in Groundwater in the Vicinity of River Road, Bristol Township, Pennsylvania. Prepared for Rohm and Haas Company. BCM Project No. 00-4061-12. March 1986.

BCM. 1986b. Report of PCE Groundwater Investigation. Prepared for Rohm and Haas Company, Bristol, Pennsylvania. BCM Project No. 00-4016-16. April 1986.

BCM. 1986c. Landfill Groundwater Sampling. February 1985 and July 1985. Prepared for Rohm and Haas Company. BCM Project No. 00-4016-14. May 1986.

BCM. 1986d. Aquatic Baseline Survey of Hog Run Creek, A Tidal Tributary to the Delaware River. Prepared for Rohm and Haas, Delaware Valley Inc., Bristol, Pennsylvania. BCM Project No. 00-4016-25. May 1986.

Environmental Protection Agency (EPA). 1987. Data Quality Objectives for Remedial Response Activities. Office of Emergency and Remedial Response and Office of Waste Program Enforcement. March 1987. EPA 540/G-87/003A.

Environmental Protection Agency (EPA). 1986a. Guidelines for Carcinogenic Risk Assessment. Fed. Reg. 51: 33992 - 34002 (September 24, 1986).

Environmental Protection Agency (EPA). 1986b. Guidelines for Exposure Assessment. Fed. Reg. 51: 34042 - 34054 (September 24, 1986).

Environmental Protection Agency (EPA) - 1986c. Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy. Office of Groundwater Protection (WH-550G). December 1986.

Environmental Protection Agency (EPA). 1986c. Superfund Public Health Evaluation Manual. Office of Emergency and Response. October 1986. EPA 540/1-86/060 (OSWER Directive 9285.4-

Environmental Protection Agency (EPA). 1984a. Health Affects Assessment for Arsenic. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-020.

Environmental Protection Agency (EPA). 1984b. Health Effects Assessment for Chloroform. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-010.

Environmental Protection Agency (EPA). 1984c. Health Effects Assessment for 1,2 Dichloroethane. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-002.

Environmental Protection Agency (EPA). 1984d. Health Effects Assessment for Methylene Chloride. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-028.

Environmental Protection Agency (EPA). 1984e Health Effects Assessment for Tetrachloroethene. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-009.

Environmental Protection Agency (EPA). 1984f Health Effects Assessment for Trichloroethene. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-046.

Environmental Protection Agency (EPA). 1984g Health Effects Assessment for Vinyl Chloride. Environmental Criteria and Assessment Office, Cincinnati, Ohio. September 1984. EPA 540/1-86-036.

Greenman, David W., 1955. Ground Water Resources of Bucks County, Pennsylvania. Pennsylvania Geologic Survey, Harrisburg, Pennsylvania.

Greenman, David W., W. N. Lockwood, and H. Meisler, 1961. Ground Water Resources of the Coastal Plain Area of Southeastern Pennsylvania. Pennsylvania Geologic Survey, Harrisburg, Pennsylvania.

Hall, George M., 1973. Ground Water in Southeastern Pennsylvania. Pennsylvania Geologic Survey, Harrisburg, Pennsylvania.

Kammerer, J. C., 1953. Ground Water Resources of Bucks County, Pennsylvania (Map). U.S. Geological Survey (Included in Greenman, 1955 Publication).

NUS Corporation. 1985. A Hazard Ranking System for Croydon TCE. Prepared for the Hazardous Site Control Division, U.S. Environmental Protection Agency. TDD No. F3-8503-10. (April 4, 1985).

Owens, James, P., and J. P. Manard, 1964. Pre-Quaternary Geology of the Bristol Quadrangle, New Jersey - Pennsylvania. U.S. Geologic Survey, Washington, D.C.

Porter, Winston J., 1986. Interim Guidance on Superfund Selection of Remedy. Office Solid Waste and Emergency Response. December 24, 1986.

A

AR300108

APPENDIX A

FEDERAL AND COMMONWEALTH OF PENNSYLVANIA ARARs

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
CROYDON TCE SITE

Federal ARARs

- Resource Conservation and Recovery Act (RCRA) of 1976 (Amended 1984) - Governs the generation, transportation, storage, and disposal of hazardous wastes. RCRA 40 CFR Part 264 standards are used for remedial actions including offsite hauling and disposal of hazardous wastes, onsite capping and landfilling, and groundwater monitoring.

- Safe Drinking Water Act - The Safe Drinking Water Act promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs). MCLs are enforceable standards for contaminants in public drinking water supply systems. They not only consider health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. EPA has also recently proposed Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are non-enforceable guidelines that do not consider the technical feasibility of contaminant removal.

- Toxic Substances Control Act of 1976 - The Toxic Substances Control Act (TSCA) provides authority to require testing of chemical substances entering the environment and to regulate them, where necessary. Polychlorinated biphenyl (PCB) regulation and enforcement (40 CFR Part 761) are important aspects of TSCA. 40 CFR Part 761 established regulations for manufacturing, processing, distribution in commerce, and use prohibitions for PCB.

- USEPA Health Advisories - Health Advisories are non-enforceable guidelines, developed by the EPA Office of Drinking Water, for chemicals that may be intermittently encountered in public water supply systems. Health Advisories are available for short term, longer-term, and lifetime exposures for a 10 kg child and/or a 70 kg adult.

- Clean Water Act (as amended) - Governs point-source discharge through the National Pollutant Discharge Elimination System (NPDES), discharge of dredge or fill materials, and oil and hazardous spills to U.S. waters.

  Also, Ambient Water Quality Criteria (AWQC) were developed for 64 pollutants in 1980 (45 CFR Part 28L) pursuant to Section 304(a)(1) of the Clean Water Act.

In 1983, EPA revised nine criteria previously published in the "Red Book" (Quality Criteria for Water, 1976), and in the 1980 criteria documents. These criteria are not legally enforceable, but have been used by many states to develop enforceable water quality standards. AWQC are available for the protection of human health from exposure to contaminants in drinking water, from ingestion of aquatic biota, and for the protection of freshwater and saltwater aquatic life.

- Clean Air Act of 1967 - Governs air emissions resulting from remedial actions. The Clean Air Act promulgated the National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50). NAAQS are available for six chemicals or groups of chemicals and for airborne particulates. The sources of the contaminant and the route of exposure were considered in the formulation of the standards. These standards do not consider the costs of achievement or the feasibility of implementation. The NAAQS allow for a margin of safety to account for unidentified hazards and effects.

- Section 404(b)(1), Guideline for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Part 23) - Established guidelines applicable to the dredge and fill of wetland environments.

- Dredged Material Disposal Sites Denial or Restriction Procedures (Section 404 Procedures) (40 CFR Part 231) - Established procedures for prohibiting or withdrawing the specification, or denying, restricting, or withdrawing the use for specification, of any defined area as a disposal site for dredged or fill material pursuant to Section 404(c) of the Clean Water Act.

- Regulation of Activities Affecting Water of the U.S. (33 CFR Parts 320-329) - U.S. Army Corps of Engineers Regulations that are applicable to wetlands and navigable waters.

- Occupational Safety and Health Act (OSHA requirements; 29 CFR Parts 1910, 1926, and 1904) - OSHA regulations provide occupational safety and health requirements applicable to workers engaged in onsite field activities.

- Federal Floodplain Executive Order (11988) - Provides for consideration of floodplains during remedial actions. This Executive Order is to be considered as implemented by EPA's August 6, 1985 Policy on Floodplains and Wetlands Assessments for CERCLA Actions (CERCLA Compliance Policy).

- Federal Wetlands Executive Order (11990) - Provides for consideration of wetlands during remedial actions. This Executive Order is to be considered as implemented by EPA's August 6, 1985 Policy on Floodplains and Wetlands Assessments for CERCLA actions (CERCLA Compliance Policy).

- DOT Rules for Hazardous Materials Transport (49 CFR, Parts 107, 171.1 - 171.500) - Regulates the transport of hazardous waste materials including packaging, shipper equipment, and placarding. These requirements are considered applicable to any wastes shipped off site for laboratory analysis, treatment, or disposal.

- Endangered Species Act of 1978 (16 USC 1531) - Provides for consideration of the impacts on endangered and threatened species.

- Fish and Wildlife Coordination Act (16 USC 661) - Provides for consideration of the impacts on wetlands and protected habitats.

- Fish and Wildlife Improvement Act of 1978 (16 USC 742a) - Provides for consideration of the impacts on wetlands and protected habitats.

- Fish and Wildlife Conservation Act of 1960 (16 USC 2901) - Provides for consideration of the impacts on wetlands and protected habitats.

- Pesticide Registration, Tolerances, and Action Levels - Based on the production history of Drake Chemical (i.e., manufacture of herbicides and pesticides), pesticide registration, tolerances, and action levels may be applicable.

- Health Effects Assessments (HEAs) - HEAs present toxicity data for specific chemicals for use in public health assessments. Also considered applicable are Carcinogenic Potency Factors and Reference Doses provided in the Superfund Public Health Evaluation Manual (USEPA, 1986).

- Groundwater Protection Strategy - EPA's policy is to protect groundwater for its highest present or potential beneficial use. This policy will be incorporated into future regulatory amendments. The strategy designates three categories of groundwater:

  - Class 1 - Special Groundwaters - Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

- Class 2 - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses - Waters that are currently used or that are potentially available.

- Class 3 - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use - Class 3 groundwater units are further subdivided into two subclasses.

  - Subclass 3A includes groundwater units which are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class 2 groundwaters depending upon the potential for producing adverse effects on the quality of adjacent waters.

  - Subclass 3B is restricted to groundwater units characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking waters in such a way that there is little potential for producing adverse effects on quality. They have low resource values outside of mining or waste disposal.

State of Pennsylvania ARARs

- Pennsylvania Solid Waste Disposal Regulations - Governs the generation, transportation, storage, and disposal of hazardous wastes.

- Pennsylvania National Pollutant Discharge Elimination System (NPDES) Rules - Governs point-source discharge to Pennsylvania waters through the Clean Water Act.

- Pennsylvania Water Quality Standards - Sets forth water quality standards for receiving streams based upon designated uses.

- Pennsylvania Wastewater Treatment Requirements - Wastewater treatment regulations required to maintain water quality, including effluent limitations based on best practical control technologies and waste level allocations for pollutants at which minimum treatment requirements have not been established.

- Pennsylvania Industrial Waste Treatment Regulations - Provides requirements and standards for treatment of industrial waste discharges to surface waters and underground waters.

- Pennsylvania Special Water Regulations - Establishes a procedure for mandatory notification of downstream users in the case of an accident in which a toxic substance enters surface waters. These regulations also specify bonding requirements for solid waste facilities that would ensure closure of a permitted site in a manner that would abate or prevent water pollution.

- Pennsylvania Air Pollution Control Regulations - Governs air emissions from remedial actions. Provides for the control and prevention of air pollutants and guidance for the design and operation of air pollution sources.

- Pennsylvania Storm Water Management Act - Requires measures to control stormwater runoff during alterations or development of land. Stormwater management systems must be constructed in a manner consistent with the county watershed management plan.

- Pennsylvania Erosion Control Regulations - Governs erosion and sedimentation control resulting from remedial actions that may involve earth-moving activities.

- Pennsylvania Hazardous Substances Transportation Regulations - Regulates the transport of flammable liquids and solids, oxidizing materials, poisons, and corrosive liquids. These requirements may be applicable to any wastes shipped offsite for laboratory analysis, treatment, or disposal.